Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

- Agriculture & Life Sciences
- Architecture & Urban Studies
- College of Engineering
- Liberal Arts and Human Sciences
- Natural Resources and Environment
- Pamplin College of Business
- College of Science
- Veterinary Medicine

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Academic Calendars

Calendar 2019-2020

Fall 2019

Monday	August 26	Classes Begin
Monday	September 2	Labor Day (No Classes - University Offices Closed)
Friday	October 4	Fall Break (No Classes - University Offices Open)
Saturday	November 23	Thanksgiving Holiday Begins
Sunday	December 1	Thanksgiving Holiday Ends
Wednesday	December 11	Classes End
Thursday	December 12	Reading Day
Friday	December 13	Exams Begin
Thursday	December 19	Exams End
Friday	December 20	University and Graduate School Commencement Ceremonies

Winter 2020

Virtual, Blended, or Winter Experience (VBW)

Thursday	December 26	Classes Begin
Friday	January 17	Classes End
Saturday	January 18	Exam Day

Residential (Blacksburg)

Friday	January 3	Classes Begin
Friday	January 17	Classes End
Saturday	January 18	Exam Day

Spring 2020

Monday	January 20	Martin Luther King Holiday (No Classes - University Offices Closed)
Tuesday	January 21	Classes Begin
Saturday	March 7	Spring Break Begins
Sunday	March 15	Spring Break Ends
Wednesday	May 6	Classes End
Thursday	May 7	Reading Day
Friday	May 8	Exams Begin
Wednesday	May 13	Exams End
Thursday	May 14	Graduate Commencement Ceremony and Senior Day
Friday	May 15	University Commencement and College/Departmental Ceremonies
Saturday	May 16	College and Department Commencement Ceremonies

Summer 2020

Summer I

Tuesday	May 26	Classes Begin
Thursday	Jul 2	Classes End
Monday	Jul 6	Exams Begin
Tuesday	Jul 7	Exams End

Summer II

Wednesday	July 8	Classes Begin
Friday	Aug 14	Classes End
Saturday	August 15	Exams Begin
Monday	August 17	Exams End

Calendar 2020-2021

Fall 2020

Monday	August 24	Classes Begin
Monday	September 7	Labor Day (No Classes - University Offices Closed)
Friday	TBD	Fall Break (No Classes - University Offices Open)
Saturday	November 21	Thanksgiving Holiday Begins
Sunday	November 29	Thanksgiving Holiday Ends
Wednesday	December 9	Classes End
Thursday	December 10	Reading Day
Friday	December 11	Exams Begin
Thursday	December 17	Exams End
Friday	December 18	University and Graduate School Commencement Ceremonies

Winter 2021

Virtual, Blended, or Winter Experience (VBW)

Saturday	December 26	Classes Begin
Friday	January 15	Classes End
Saturday	January 16	Exam Day
Residential (Blacksburg)		
Monday	January 4	Classes Begin
Friday	January 15	Classes End
Saturday	January 16	Exam Day

Spring 2021

Monday	January 18	Martin Luther King Holiday (No Classes - University Offices Closed)
Tuesday	January 19	Classes Begin
Saturday	March 6	Spring Break Begins
Sunday	March 14	Spring Break Ends
Wednesday	May 5	Classes End
Thursday	May 6	Reading Day
Friday	May 7	Exams Begin
Wednesday	May 12	Exams End
Thursday	May 13	Graduate Commencement Ceremony and Senior Day
Friday	May 14	University Commencement and College/Departmental Ceremonies
Saturday	May 15	College and Department Commencement Ceremonies

Summer 2021

Summer I		
Monday	May 24	Classes Begin
Thursday	July 1	Classes End
Friday	July 2	Exams Begin
Saturday	July 3	Exams End
Summer II		
Tuesday	July 6	Classes Begin
Thursday	August 12	Classes End
Friday	August 13	Exams Begin
Saturday	August 14	Exams End

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Academic Policies

Academic Eligibility

Continued enrollment at Virginia Tech is a privilege granted so long as the student is making satisfactory progress toward attaining a degree, maintenance of the required minimum Grade Point Average (GPA), and

compliance with all policies outlined in the *Hokie Handbook.*

Students who maintain the required minimum cumulative grade point average of 2.00 are considered to be in good academic standing with the university and are eligible for continued enrollment at Virginia Tech. Students on academic probation and warning are eligible for continued enrollment (absent any violations of policies outlined in the *Hokie Handbook.*

Academic Warning: Students earning less than a 2.00 term GPA, but with a cumulative grade point average of 2.00 or higher, will be placed on academic warning without notation on the academic transcript. Students on academic warning will be required to consult with the appropriate undergraduate assistant or associate dean of their college and to sign an academic contract. Failure to complete an action plan (academic contract) may result in prohibition from future enrollment(s).

Academic probation is imposed when a student's cumulative GPA is less than 2.00; academic probation is lifted when their cumulative GPA is at least 2.00. Academic performance will be reviewed at the end of each regular semester (fall and spring).

A student on **probation:**

1. may take no more than 16 credits per semester;
2. may be required (at the discretion of individual colleges) to consult with an academic advisor regularly and to sign an academic contract acknowledging their performance is not meeting university standards and stating what actions they are committed to taking to improve academic performance.

First suspension will be imposed when a student on academic probation has a cumulative GPA less than 2.00 for two consecutive semesters (Fall and Spring) of enrollment. A student must earn a minimum of a 2.50 term GPA for each (Fall and Spring) semester or raise their cumulative GPA to a 2.00 to avoid being placed on academic suspension.

First Suspension: A student who is placed on first academic suspension at the end of a fall or spring semester will be suspended from continued enrollment through the end of the subsequent fall or spring spring semester. **Note:** Students placed on first academic suspension at the end of fall semester are eligible to return the subsequent first summer, second summer, or fall semester.

A student must earn a minimum 2.00 semester GPA the first semester back and raise their cumulative GPA to at least 2.00 by the end of the second semester back or earn a minimum 2.50 semester GPA for every subsequent semester following the suspension until their cumulative GPA is 2.00 or greater. A student will be placed on **second academic suspension** for failure to meet these minimum performance requirements upon their return.

Second Suspension (Fall): A student who is placed on second academic suspension at the end of a fall semester will be suspended from continued enrollment through the end of the following fall semester. **Note:** Students placed on second academic suspension at the end of fall semester may NOT enroll in the immediately following summer sessions.

Second Suspension (Spring): A student who is placed on second academic suspension at the end of a spring semester will be suspended from continued enrollment through the end of the following spring semester. **Note:** Students placed on second academic suspension at the end of spring semester may NOT enroll in the immediately following summer sessions. The same minimum returning performance requirements apply for second suspension as for first suspension.

Final Suspension: A student will be permanently dismissed for failure to meet the minimum returning performance requirements after a second academic suspension.

Academic Eligibility Appeals

Students who are suspended due to academic eligibility at the end of fall or spring terms may appeal their suspension to the University Appeals Committee. The University Appeals Committee is comprised of the

associate deans of undergraduate studies of the academic colleges and one faculty member appointed by the Vice Provost for Undergraduate Academic Affairs. A representative of the Dean of Students Office participates as a non-voting member of the committee to provide any information and background available through their advocacy services. The University Appeals Committee is an advisory committee to the Vice Provost for Undergraduate Academic Affairs.

Any appeal for exceptions to the academic eligibility requirements must be based on clear extenuating circumstances beyond a student's control that negatively impacted academic performance. If an appeal is based on physical, psychiatric, or disability/learning disability reasons, the appeal must be reviewed by the Health Evaluating Committee. A recommendation letter from the appropriate office is required to complete an appeal petition.

Students must complete an academic appeals petition and submit all required documentation to the associate dean of their major college by the published college deadline. Failure to meet the published deadline results in the loss of opportunity to appeal for the term. Students have a right to appear in person at the appeals meeting. Students may not bring an outside advocate to an appeals meeting.

Full instructions and forms for academic appeals are available on each academic college website along with the dates of the academic appeals meetings. The associate dean of the student's major college may require a preliminary meeting to discuss the appeal. The associate dean also may establish an independent submission deadline prior to each University Appeals committee meeting.

If the University Appeals Committee denies an appeal, the student may request further consideration of the academic appeal by the provost's representative. The decision of the provost's representative is final and there is no further recourse.

Accreditation

Virginia Tech is accredited by the Southern Association of Colleges and Schools Commission on Colleges to award doctoral, masters, baccalaureate, and associate degrees. Contact the Southern Association of Colleges and Schools Commission on Colleges at 1866 Southern Lane, Decatur, Georgia 30033-4097 or call 404-679-4500 for questions about the accreditation of Virginia Tech.

Department	Program Description	Accred. Agency	USDOE Specialized Accred. Agency	Accred. Period	OnCampus Contact	Next Accred. Period
College of Agriculture and Life Sciences						
Agricultural and Applied Economics	Bachelor of Science in Applied Economic Management - Financial Planning Option	Certified Financial Planner Board of Standards, Inc.	No	2015-2017	Dr. Ruth Lytton	
Human Nutrition, Foods, and Exercise	Internship Program in Nutrition and Dietetics	Accreditation Council for Education in Nutrition and Dietetics (ACEND)	Yes	2013-2018	Carol Papillon	2018-2024
Human Nutrition, Foods, and Exercise	Didactic Program in Dietetics (DPD) at the baccalaureate level	Accreditation Council for Education in Nutrition and Dietetics (ACEND)	Yes	2013-2018	Heather Cox	2018-2024

College of Architecture and Urban Studies						
Architecture	Bachelor of Architecture (5 year professional degree; 160 undergraduate credits)	National Architectural Accrediting Board (NAAB)	No	2012-2018	Henri de Hahn	2018
Architecture	Master of Architecture 2 (pre-professional degree + 54 graduate credits)	National Architectural Accrediting Board (NAAB)	No	2012-2018	Henri de Hahn	2018
Architecture	Master of Architecture 3 (non-pre-professional degree + 84 credits)	National Architectural Accrediting Board (NAAB)	No	2012-2018	Henri de Hahn	2018
Building Construction	Bachelor of Science, Building Construction Science & Mgmt (MS), Environmental Design & Planning (PhD)	American Council for Construction Education (ACCE)	No	2011-2017	Yvan Beliveau	
Center for Public Administration and Policy	Master of Public Administration	National Association of Schools of Public Affairs and Administration (NASPAA)	No	2009-2012	Karen Hult	2016
Interior Design Program	Bachelor of Science	Council for Interior Design Accreditation	No	2012-2018	Lisa Tucker	2018
Landscape Architecture	Bachelor of Landscape Architecture	Landscape Architectural Accreditation Board (LAAB)	No	2007-2013	Brian Katen	Currently in progress
Pamplin College of Business						
Accounting	Undergraduate, Masters, and Ph.D. Programs	Association to Advance Collegiate Schools of Business International (AACSB International)	No	2015-2019	Dr. Reza Barkhi	
Finance	Bachelor of Science in Business, CFP Certification Education Track	Certified Financial Planner Board of Standards, Inc.	No	2015-2017	Dr. Ruth Lytton and/or Derek Klock	
General	Undergraduate, Master, and Ph.D. Programs	Association to Advance Collegiate Schools of Business International (AACSB	No	2015-2019	Dean Robert Sumichrast	

		International)				
College of Engineering						
Computer Science		Computing Accreditation Commission of ABET				
All other College of Engineering undergraduate programs		Engineering Accreditation Commission of ABET				
College of Liberal Arts and Human Sciences						
Communication	B.A. in Communication, Public Relations major	Public Relations Society of America	No	2013-2019	Dr. Robert E. Denton, Jr.	
School of Education	All school preparation programs + initial teacher preparation and advanced levels	National Council for Accreditation of Teacher Education (NCATE) - current accreditation. Next accreditation is with the Council for the Accreditation of Educator Preparation (CAEP)	Yes	2011-2018	Dr. Nancy Bodenhorn	
School of Education	All school preparation programs + initial teacher preparation and advanced levels	Virginia Department of Education (VDOE)	No	2015-Present	Dr. Nancy Bodenhorn	
School of Education	Counselor Education (MA and PhD)	Council for Accreditation of Counseling and Related Educational Programs (CACREP)	No	2015-2017	Dr. Gerard Lawson	
Gerontology	Graduate Degree Program	Association for Gerontology in Higher Education	No	2000-present	Dr. Rosemary Blieszner	
Human Development	Master's Degree (in Northern Virginia)	Commission on Accreditation for Marriage and Family Therapy Education (COAMFTE)	No	2013-2019	Dr. Eric McCollum	
Human Development	Ph.D. Program (in Blacksburg)	American Association for Marriage and Family Therapy (AAMFT)	No	2010-2016	Dr. Scott Johnson	
		National Association				

Music	Bachelor's Degree (Music)	of Schools of Music, Commission on Accreditation (NASM)	Yes	2005-2016	Dr. William J. Crone	
ROTC - Army	Army ROTC is not a degree producing program. However; Upon successful completion of a degree from Virginia Tech, we offer a Commission (as a 2LT) into the United States Army.	U.S. Army Cadet Command	No	2014-Present (Continual) Based upon the Active Duty Orders of the Officers / Instructors assigned to this unit.	COL Kevin W. Milton or Ms. Debra Harry	
Theatre Arts	Bachelor's Degree (Theatre Arts)	National Association of Schools of Theatre (NAST)	Yes	2009-2018	Prof. Patricia Raun	
College of Natural Resources & Environment						
Forest Resources and Environmental Conservation	Bachelor of Science - Forestry Major: Forestry Resource Management Option	Society of American Foresters	No	2016-2025	Dr. Janaki Alavalapati	
Forest Resources and Environmental Conservation	Bachelor of Science - Forestry Major: Urban Forestry Option	Society of American Foresters	No	2016-2025	Dr. Janaki Alavalapati	
Forest Resources and Environmental Conservation	Professional Forestry Degree (PFD): Forest Operations and Business Option	Society of American Foresters	No	2016-2025	Dr. Janaki Alavalapati	
Sustainable Biomaterials	Bachelor of Science	Society of Wood Science and Technology	No	2015-2025	Dr. Audrey Zink-Sharp	
College of Science						
Chemistry	Bachelor of Science	American Chemical Society	No	2014-2020	Dr. Jim Tanko and Dr. Gordon Yee	
Psychology	Clinical Training Program, Clinical Psychology	American Psychological Association	Yes	2014-2021	Dr. Bob Stephens	
College of Veterinary Medicine						
Full college accreditation	Full college accreditation	American Veterinary Medical Association (AVMA)	Yes	2015-2022	Dr. Jennifer Hodgson	
	Master of Public	Council on			Susan	

Public Health	Health	Education for Public Health	Yes	2013-2018	Marmagas	2018
Outreach and International Affairs						
Language and Culture Institute/Intensive English Program	The Virginia Tech Language and Culture Institute provides language-related programs and services for academic and professional development.	Commission on English Language Program Accreditation	Yes	2018-2027	Donald R. Back	
Virginia Tech						
University accreditation	University accreditation	Southern Association of Colleges and Schools (SACS)	Yes	2010 - 2019	Dr. Kenneth Smith	

Applying for Your Degree

All students must apply for a degree during the first semester of their junior year. The application for degree can be found on Hokie SPA under the Degree Menu. Once students have completed the application, they should generate a Degree Audit Report (DARS). The DARS report will help students to be fully aware of all degree requirements, which remain to be completed. This report can also be generated through Hokie SPA.

Double Major(s): Undergraduate students who fulfill the requirements for two majors concurrently will receive recognition of the second major (double major) by including the additional major on their application for degree on Hokie Spa. Only the primary major will appear on the diploma. Students will receive double major certificates in recognition of the second major. The additional major will be included on students' official transcripts.

Second Undergraduate Degree: Students may earn a second bachelor's degree (and diploma) by earning a minimum of 30 additional credit hours in **residence** with a minimum 2.00 GPA on all work attempted. All specific requirements must be met for each degree program, including attainment of the 2.00 GPA for all courses in the major. Note: The threshold for the total number of pass/fail hours allowed may not exceed the maximum for the first degree.

Traditionally, degrees are conferred upon candidates who are present to receive them at the Commencement ceremony in May. Candidates may have their degrees conferred in absentia if they cannot be present at Commencement. To arrange for this, a candidate must indicate to the University Registrar either via Hokie SPA or in writing to be excused from the Commencement ceremony.

In addition to the traditional Commencement, other "Degree Conferral Dates" have been established for each May to May year. The degree conferral dates for fall, winter, first summer, and second summer appear on the diplomas of qualified graduates. The degree conferral dates fall on the last day of final examinations (last day of term) for first summer session, second summer session, fall semester, and winter term. Names of graduates of summer and fall terms will appear in the fall commencement ceremony program only.

No commencement ceremonies are conducted at the end of the summer sessions, but graduates may attend the fall ceremony after completion of degree requirements. They may also request permission from the department to "walk through" the spring commencement ceremony based on established departmental or college guidelines. Diplomas are not distributed.

Completion of degree requirements is determined after the final grade reports are available. Degrees are regarded as having been conferred on the appropriate conferral date upon determination by the University

Registrar that degree requirements have been met. All course enrollments and attendance obligations must have been completed on or before the degree conferral date. University actions, such as Honor System or Conduct System sanctions, may delay the awarding of a degree, the effective term of the degree and release of the diploma. Students with university actions will have their final degree conferral date moved in accordance with the completion of sanctions. Students who are unable to complete degree requirements based on their original application for degree term are responsible for moving their date of completion.

With the exception of spring and fall semesters, students may resolve degree completion problems up to thirty (30) days after the degree term to retain the conferral date on the diploma. Spring and fall degree candidates must resolve any graduation issues by the end of the next month following the degree conferral dates for these terms. Any resolutions of degree completion problems, subsequent to these resolution windows will be conferred on the next degree conferral date. Unresolved degree problems include failure to submit appropriate paperwork to the university.

Other than spring semester, diplomas for all other "Degree Conferral Dates" are ordered after course work completions are established. Diplomas are distributed either by mail or in person to graduates who appear in the Office of the University Registrar.

Assessment of Student Learning Experiences

A critical element in the continuous improvement of programs and services at Virginia Tech is the evaluation of student learning experiences, perceptions, and academic achievement. Each student may be asked to participate in assessment activities, including but not limited to course assignments, surveys, focus groups, end of course evaluations, tests, and personal interviews. Student involvement in these assessment activities will assist Virginia Tech in providing current and future students with high-quality learning experiences in keeping with the mission of the University.

Combination Degrees

The bachelor's degree will be awarded to a student who has satisfactorily completed three years of undergraduate work in an appropriate curriculum and the first year of work in an accredited medical, dental, veterinary, or law school, or medical technology program (biology majors only), or physical therapy program (biology majors only), provided the student fulfills the requirements for the three-year program as follows:

- At least two of the three years of pre-professional work, including the third year in residence, must be at the university.
- A minimum of 90 semester hours undergraduate work, i.e. pre-professional school credit, must be earned.
- Curriculum for Liberal Education requirements must be met, plus at least 18 of the 30 hours required in the major during the three-year, pre-professional work program. A department may require more than 18 hours of course work in the major.

Degree Programs

Virginia Tech offers four-year degree programs leading to a Bachelor of Arts, Bachelor of Science, or Bachelor of Fine Arts degree. Also offered are five-year Bachelor of Architecture and Bachelor of Landscape Architecture programs. Virginia Tech also offers graduate work in 76 fields of study leading to masters degrees and in 62 fields leading to doctoral degrees. A professional degree is offered through the Virginia-Maryland Regional College of Veterinary Medicine, located at Virginia Tech, and a medical degree from the Virginia Tech Carilion School of Medicine.

Directed and Independent Enrollment

Virginia Tech offers several types of courses that can be tailored to the needs of individual students or special groups. By allowing students to pursue topics in which formal courses are not available, these directed and

independent courses provide greater flexibility in course offerings. They also provide students an opportunity to assume a greater share of the responsibility for their own education outside the traditional classroom situation.

In order to enroll in a directed or independent course, students must develop a plan of work to reach particular objectives, obtain approval of both the department and the faculty member who will supervise the work, and work with them to arrange hours and credits.

Students must submit an official approval form prior to registration. In most cases, the student's first contact for an independent study, field study, or undergraduate research course is the department offering the course. Registration is through the student's dean's office. Special study courses are set up by the department, and the student registers through web course request. Some colleges and departments have restrictions on eligibility to register for these courses, and limit the number of hours that can be used toward graduation.

A student may take 12 credit hours of independent study and/or undergraduate research to be counted toward their undergraduate degree, exclusive of indeoendent study and/or undergraduate research courses required by a specific degree as indicated on a checksheet.

Each time the student enrolls in independent study or undergraduate research, the instructor is required to identify a tangible output produced by the student at the end of the course that will be sued to determine the student's grade

The time that the student devotes to satisfying course requirements shall be reflected in the number of credit hours awarded based on the Carnegie Foundation definition.

Field Study (X964) courses are work experiences approved by some departments and are selected to augment traditional classroom activities. The student is evaluated on the knowledge and skills acquired as a result of the experience. Emphasis is placed on the academic and practical value of the work.

Independent Study (X974) courses generally involve extensive reading and tutorial sessions with the faculty supervisor and also may involve written papers and other assessments. The subject of Independent Study usually is a continuation in greater depth of a topic covered in a regular course, allowing students to study topics of particular individual interest.

Special Study (X984) courses are designed for a group of students, rather than for a single individual. This type of course may be used to study a timely topic, one in which there is current, but not necessarily lasting, interest. It also may be used to launch an experimental course before incorporating it into the regular curriculum.

Undergraduate Research (X994) courses are individual research projects carried out by students under faculty supervision. The student defines the research topic, proposes a methodology, carries out the research, and writes a report.

Global Education

Virginia Tech students have the opportunity to study abroad through various programs spanning the globe.

Study abroad programs touch on almost every academic discipline and provide the opportunity to develop or strengthen global competency. Students can experience an academic discipline at work in an international setting, improve language skills, cultivate new intellectual interests, challenge assumptions about their own and foreign cultures, and build intercultural networks, understanding, and communication skills of value to future employers..

The Steger Center for International Scholarship, located in the picturesque town of Riva San Vitale, Switzerland, is Virginia Tech's study center in Europe. Housed in a 250-year-old villa, the Steger Center provides classrooms, a library, an architecture studio, study and lounge areas, a cafeteria, and a garden in an unforgettable setting. The central location allows for excursions to other European sites that complement classroom instruction. Steger Center programs offer courses in architecture, geosciences, the humanities,

University Honors, and Italian that may count toward Curriculum for Liberal Education and major requirements. Students may participate in semester-long programs in the fall and spring or short-term programs in the summer.

Virginia Tech also has a growing number of **study abroad opportunities in Africa**. Growing more rapidly than any other part of the world and representing the next great frontier for innovations in business, science, and technology, Africa is a critical region for the world's future. The opportunity to live and study shoulder-to-shoulder with Africa's youth as they rise to meet the extraordinary challenges of their future offers VT students a unique pathway to academic, personal, social, and professional growth.

Faculty-led programs on every continent provide another option for international experience. Virginia Tech faculty design and lead more than 70 short-term courses abroad during the winter or summer terms. Participants in faculty-led programs have the ability to focus on a specific course or discipline while navigating the culture along with a faculty member and fellow Hokies.

Additionally, through Virginia Tech's international partnerships and membership in the International Student Exchange Program (ISEP) consortium, students can study on exchange for a semester or year at one of over 200 universities worldwide, where they are immersed in the local classroom, culture and community. Students who participate in **bilateral and ISEP student exchange programs** pay their regular home campus tuition and fees for the term of study, and tuition at the host university is waived. Semester exchanges serve all majors and are available in Latin America (Central and South), Europe (including Iceland and Scandinavia), Africa (North and Sub-Saharan), the Middle East, Asia (East and Southeast), and Oceania.

Semester/academic year programs are also available through other study abroad third-party or non-Virginia Tech providers.

Students should meet with an academic advisor early in the study abroad planning process to determine how classes taken abroad will fit into a degree program and how credit is awarded. Students must obtain pre-approval for all credits to be transferred to Virginia Tech for use toward degree completion and must register their study abroad program with the Global Education Office. All non-VT credits taken abroad return as transfer credit: the grade does not appear on the VT transcript and is not factored into the GPA. For course credit to transfer, an equivalent grade of "C" or better is required and courses must be reported on an official transcript either from an institution recognized by the Ministry of Education and authorized to grant degrees in its home country or from a US-accredited college or university. A minimum of 25% of the credits for the degree must be earned at Virginia Tech.

- Of the last 45 hours before graduation, only 18 semester hours may be transferred from another institution.
- A course passed at VT takes priority over a transfer equivalent course.
- Pass/Fail, extra credit, home study courses, correspondence courses, terminal or vocational courses do not transfer.
- Online courses are eligible for transfer.
- If completing more than one degree (not a second major) only courses for the primary degree will transfer.
- Students completing more than one degree (not a second major) must complete an extra 30 hours for their second degree in residence (at Virginia Tech).
- Authorization is denied if a student is on academic suspension while taking the course(s).
- Transfer credits do not affect GPA, but professional and graduate schools will typically review the grades on the original transcript.

Apart from credits, students and parents considering study abroad programs typically have questions regarding costs. Program costs can vary largely depending on various factors including location, length, and program type. Most forms of financial aid may be applied to study abroad, and there are several scholarships and grants available. Students are encouraged to contact the Office of Scholarships and Financial Aid as soon as they consider studying abroad.

For all questions regarding study abroad, students are encouraged to visit the Global Education Office website

or visit the office to speak with an advisor.

The Global Education Office strives to strengthen the university's mission of global engagement, discovery, and service by connecting faculty and students to peers abroad; inspiring and contributing to the faculty's creation and promotion of cross-cultural learning experiences; and supporting the development of Virginia Tech students into globally competent citizens. For more information, contact the Global Education Office at 526 Prices Fork Road, Room 131, or consult: **www.globaleducation.vt.edu**.

Graduation Requirements and Degree Conferrals

The approved requirements in effect for the year/term of application for degree apply. A student must complete all courses with at least a minimum 2.00 GPA for all hours attempted. In addition, a student must present an equally satisfactory record in courses attempted in the major and/or any minor. The number of credit hours required varies from one major to another. Virginia Tech reserves the right to modify requirements in the student's program if necessary. Degrees must be approved two years prior to their effective use. The approved graduation requirements (referenced as graduation checksheets) appear at the University Registrar website: **https://registrar.vt.edu/graduation-multi-brief/index1.html**.

All students must earn 25% of credits required for their respective degree from Virginia Tech. No more than fifty (50) percent of credit hours earned from a two-year institution may be used to satisfy graduation requirements. Students who must enroll in foreign language courses to complete admission requirements may not use the credits toward completion of the degree.

Undergraduate students are permitted to complete a maximum of 18 of their last 45 hours *in absentia* and to transfer to complete their graduation requirements, so long as the request to transfer these credits meets all the current requirements in effect (transfer transcript is required and approval of the student's Academic Dean). Also, the credits to be transferred may consist of required as well as elective credits, as long as, prior approval has been obtained from the student's Academic Dean to transfer any required credits. Undergraduate students studying away from campus during their last 45 hours may apply for an individual waiver of the requirement that a maximum of 18 of their last 45 hours may be earned *in absentia*. Approval of the request will be at the discretion of their academic dean. This does not preclude the requirement that at least 25% of all credits be earned in residence at Virginia Tech.

Graduation with Distinction (Academic Policies Governing Enrollment Section)

Language Study Requirement

Students must meet a language study requirement either through middle and high school enrollment or prior to receipt of the undergraduate degree. The minimum requirement may be met in middle or high school by completing two units of a single foreign or classical language or American Sign Language. Some majors in the College of Liberal Arts and Human Sciences may require 3 units of a single foreign or classical language or American Sign Language. Students completing the requirement at Virginia Tech may not count the hours toward degree completion. The requirement also may be met after admission by one of the following:

- Earning six (6) semester hours of college-level foreign or classical language credit or American Sign Language. Such credits are in addition to that number normally required for graduation in a student's program of study.
- Receiving credit by examination for a foreign or classical language or American Sign Language. The credit by examination option is available only to students who have gained knowledge of a foreign language without the benefit of formal training. This privilege is intended to recognize informal non-academic learning experience and is **not** offered to a student who has had regular classroom instruction in that foreign language. Contact the Department of Modern and Classical Languages and Literatures for more information.

Honor Code and Honor System

The Virginia Tech Honor Code is the university policy that defines the expected standards of conduct in academic affairs. The Virginia Tech honor pledge is as follows: *"As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do."* Further, students are prohibited from giving and/or receiving unauthorized assistance on their course work.

Each student who enrolls at Virginia Tech is responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any graded assignment is responsible for obtaining specific guidance from the instructor before submitting the assignment for evaluation. Students should assume that all projects and homework assignments are to be completed individually unless otherwise specified by the instructor.

Commission of any of the following acts shall constitute academic misconduct. This listing is not, however, exclusive of other acts that may reasonably be said to constitute academic misconduct.

- **CHEATING** - The intentional use of unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise, or attempts thereof.
- **PLAGIARISM** - The copying of the language, structure, programming, computer code, ideas, and/or thoughts of another and passing off the same as one's own original work, or attempts thereof.
- **FALSIFICATION** - The statement of any untruth, either verbally or in writing, with respect to any element of one's academic work, or attempts thereof.
- **FABRICATION** - Making up data and results, and recording or reporting them, or submitting fabricated documents, or attempts thereof.
- **MULTIPLE SUBMISSION** - The submission for credit without authorization of the instructor receiving the work of substantial portions of any work (including oral reports) previously submitted for credit at any academic institution, or attempts thereof.
- **COMPLICITY** - Intentionally helping another to engage in an act of academic misconduct, or attempts thereof.
- **VIOLATION OF UNIVERSITY, COLLEGE, DEPARTMENTAL, PROGRAM, COURSE, OR FACULTY RULES** - The violation of any University, College, Departmental, Program, or Faculty Rules relating to academic matters that may lead to an unfair academic advantage by the student violating the rule(s).

Instances of academic misconduct represent behavior that is of an especially serious nature. The University's normal sanction for academic misconduct is an F* as the student's final course grade. The F* sanction is intended to identify a student who has failed to uphold the values of academic integrity at Virginia Tech. A student who is assessed a sanction of F* as their final course grade shall have it documented on their transcript with the notation "FAILURE DUE TO ACADEMIC HONOR CODE VIOLATION." More severe or lesser penalties may be imposed if the circumstances warrant.

The Honor Code fosters an environment that promotes fairness, personal responsibility, and integrity. More information about the Honor Code is available at **www.honorsystem.vt.edu.**

Pre-Professional Preparation

Health Professions Advising (HPA)

The university maintains an office for health professions advising which is located in the Smith Career Center. The services provided by HPA are available to all undergraduate students and alumni considering a career in a health care profession.

Health Professions Advising coordinates all health professions advising for students with an interest in but not limited to medicine (allopathic, osteopathic, and naturopathic), physician assistant, dentistry, nursing, physical therapy, occupational therapy, optometry, pharmacy, public health, veterinary medicine, genetic counseling and any others graduate level program. Although the majority of health professions students may choose to major in a science program, any major is acceptable to health professional schools so long as certain specific admission requirements are satisfied. Thus HPA provides advice and assists students in preparing for admission to a graduate health professional school. Students interested in a health career are encouraged to

pursue a broad undergraduate study in the humanities, and social sciences, as well as biology and the natural sciences. Admissions requirements for qualified students include a competitive grade point average (which varies by health profession), national standardized admissions tests for each health profession, significant participation in volunteer and clinical health care activities, letters of recommendation/evaluation, and an interview at the professional school. Successful candidates exhibit high levels of scholastic achievement and intellectual potential as well as motivation and concern for one's fellow human beings.

The office provides individual advising about careers in health professions, preparation for competitive application to professional schools, and the admission process. This office advises students regarding ways to obtain clinical experience to assist them in gaining practical experience in the health care arena through volunteering and/or working at local or regional hospitals and clinics. The Health Professions Evaluation Committee (HPEC) which is made up of faculty advisors and health professionals from the community, provides on-campus interviews and upon request, furnishes committee letters of evaluation.

Core course requirements vary among the accredited health professional schools but most require two semesters each of Mathematics, English, Biology (with labs), General Chemistry (with lab), Organic Chemistry (with lab), and General Physics (with lab). Other courses which may be required or recommended by schools include Cell and Molecular Biology, Biochemistry, Communication, Ethics, Economics, Microbiology, and Human Anatomy and Physiology. Students are strongly encouraged to pursue learning far beyond their major and prerequisite requirements. Resources are available in the Smith Career Center for investigating the specific entrance requirements for each school, and students are strongly encouraged to make use of these services.

Pre-Law Advising

Law students and lawyers come from many undergraduate backgrounds, and the skills necessary to succeed in law school and as an attorney can be developed in a variety of courses across a range of disciplines. Law schools do not treat any specific course or major as a prerequisite for admission, nor do they look with special favor on applicants who have graduated from a formal "pre-law" program. Accordingly, Virginia Tech does not offer a formal pre-law major. The university does offer a top-quality education in a large number of fields, as well as counseling about law as a career, preparing for and applying to law schools, and the law school admission process. Students are encouraged to maintain contact with academic and career advisors at Virginia Tech and others on campus with information about legal careers.

For further information on pre-law studies at Virginia Tech, including how to contact a pre-law advisor, see the following website: **http://www.prelaw.psci.vt.edu**.

Restricted Majors and Programs

Students should be aware that there are some academic majors and programs within the university that have strict entrance requirements or are in such high demand that they cannot accommodate all who wish to enter them. Administrators of these restricted programs must be selective in allowing students to transfer in from other majors within the university and in permitting second majors or minors. Students seeking entrance into such restricted programs should consult the appropriate department.

Restricted programs for internal transfers are as follows:

College of Agriculture and Life Sciences
Human Nutrition, Foods and Exercise

College of Architecture & Urban Studies
Architecture
Art (Visual Communication Design; Studio Art)
Industrial Design - major
Industrial Design - minor
Interior Design - major
Landscape Architecture

Pamplin College of Business
Accounting
Business Information Technology
Business Minor
Finance, Ins, & Bus Law
Hospitality and Tourism Management
Management
Marketing

College of Engineering
All Engineering Majors

College of Science
Biological Sciences

Selecting/Changing a Major, Double Major, or Minor

Undergraduate students must be enrolled in the major(s) in which their degree is to be awarded before their senior year, or with a minimum of 30 semester hours to complete before their graduation. Students seeking a double major must be accepted into the second major by the academic department before the university can award the second major.

Changes from one degree program to another (i.e., changes in major) or the addition of a second major or minor may sometimes imply extra course work, which can delay graduation, but changes or additions in most instances require no particular qualifications on part of the student. They usually can be accomplished prior to the senior year, simply by working with one's academic advisor and informing the head(s) of the department(s) and the dean(s) of the college(s) in question.

A major (or second major) cannot be selected after the beginning of the senior year. (See section above on Selecting a Major.) Some departments establish specific deadlines for requesting change of major. Check the department's website for specific deadlines and required application materials.

Minors are offered by many academic departments and earned simultaneously with the degree. Minors are not declared nor earned after degree completion. Refer to the section on Graduation Requirements and Degrees and to the appropriate academic department in the college chapters of this catalog to review the requirements for a minor.

Twenty-five percent of the credit hours required for a student's degree must be taken at Virginia Tech.

Procedures to Follow When Changing or Adding a Major or Minor

Students can request a new primary major through Hokie Spa during a change of major window each semester. There are three common change of major times every year, fall, spring and summer. Each respective college facilitates their own process to determine if it will accept the student into the major and will then notify them.

Requests for adding second majors or adding a minor are processed based on your college's established processes. Consult your Academic Dean's office for your college's process for declaring a second major or minor.

Selection of Studies

The regular academic year at Virginia Tech is divided into two semesters, fall and spring. Virginia Tech also offers two summer sessions and one winter session. Most courses of study require eight (8) terms (i.e., semesters and/or summer sessions) for completion of the bachelor's degree requirements. Completion of the degree requirements for those students who enroll in the Cooperative Education Program, Bachelor of Architecture Program, or Bachelor of Landscape Architecture Program requires five years.

Elective courses are chosen through consultation with the student's advisor. The dean of the college in which a student is registered has authority in such matters as substitution of courses, dropping and adding courses after deadlines, or permission to take an overload.

Students have the assistance of faculty guidance, introductory courses, and special counseling to help them choose wisely which course of study they should take. Every effort is made to assure that all courses listed under the various department of instruction will be offered. Virginia Tech reserves the right, however, to withdraw any course for which an inadequate number of students enroll.

The requirements in a major consist of:

1. specifically designated courses (all of which must be completed)
2. restricted (structured) electives from which a minimum number of courses and/or patterns must be completed
3. electives that are to be chosen from courses in the department not used for specific requirements or restricted electives and not prohibited for majors in the department

Student Responsibilities on Official Student Records

Students are responsible for keeping and being familiar with their own records and for the accuracy of these records.

A student's failure to keep their address updated does not absolve the student of responsibility for matters that require notification by the university. Changes to a student's local address, permanent address, or parent/guardian address should be promptly updated by accessing Hokie SPA. Correct residence hall addresses are established through the Housing and Residence Life Office in 144 New Hall West. If a student is not sure what addresses are on file, they may check Hokie SPA for verification. Virginia Tech requires updating of local address, designation of emergency contact, opt in/out of VT Alerts, and understanding of the Hokie Handbook prior to registration.

It is the student's responsibility to check their current schedule of classes by accessing Hokie SPA. Errors must be corrected by the established deadline stated in the Timetable of Classes. Request for course(s) will result in a responsibility for payment of tuition and fees. If a student requests courses via course request or during drop/add, the student is responsible for the tuition and fees assessed unless formally resigning during the established university deadlines. It is the student's responsibility to complete and return the Withdrawal/Resignation form by established term deadlines if choosing to disenroll for a given term.

Students are responsible for seeing their advisors during course request to assure appropriate curricula planning.

Student Responsibilities: Satisfactory Progress Towards Degree

It is the student's responsibility to satisfy all course requirements as established by the faculty teaching the courses in which they are enrolled. It is also the student's responsibility to be aware of all major, degree, college, and graduation requirements necessary to complete their degree. Additionally, students are responsible for satisfying all university, college, and departmental requirements for progress towards degree. (Consult "Checksheets" at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for major requirements.)

Student Success Center

www.studentsuccess.vt.edu
(540) 231-5499

The Student Success Center is committed to providing holistic support services and programs that develop self-directed and lifelong learners within a diverse and inclusive environment. The department offers programs and services that enrich the educational experiences of undergraduate students such as tutoring, academic coaching, mentoring, academic strategies courses, and more. All of our services offered are free to Virginia Tech students. The main office is located on the first floor of Femoyer Hall.

Educator (Teacher) Preparation

www.soe.vt.edu
edinfo@vt.edu

Virginia Tech's School of Education offers programs leading to licensure in 15 fields of study. All educator preparation programs are at the graduate level. Students seeking a teaching or other educational license should consult the School of Education Office of Academic Programs website (**http://www.oap.soe.vt.edu**) for details on specific programs of interest. Generally, the teacher preparation programs are completed in one calendar year of full-time enrollment, including student teaching, while Counseling and Administrative license programs are completed in two years.

The School of Education is accredited by the Council for the Accreditation of Education Preparation (CAEP), and all programs are approved by the Virginia Board of Education. Graduates may qualify for an educator license or endorsement in other states.

Undergraduate students who anticipate applying for a master's degree in education should consult the Pre-Education Advisor at **https://sites.google.com/vt.edu/peap/home** or peap@vt.edu or the academic advisor in their undergraduate major. Decisions about entering graduate programs in teaching should be made early in the undergraduate years so that an appropriate major can be selected and required courses can be taken prior to applying for the graduate program. For certain programs, seniors with a GPA of 3.0 or better may apply to be admitted to the Dual Student Status for their last semester to take graduate-level education courses and juniors with a GPA of 3.3 or better may apply for admission in the Accelerated Undergraduate/Graduate Degree Program to take graduate courses during the senior year. Information about these options is available on the Graduate School website (**www.graduateschool.vt.edu**)

Applicants for teacher preparation programs must submit passing scores on Praxis Core Academic Skills for Educators, or acceptable scores on the SAT or ACT prior to acceptance into the School of Education. Passing scores on relevant Praxis Subject Assessments, the Virginia Communication and Literacy Assessment, and the Reading for Virginia Educators exam (for elementary education teachers) are required prior to receiving a teaching license and prior to admission for some programs. A criminal record check is required by school divisions in Virginia prior to employment, and for most divisions for student teaching.

Notable features of the educator preparation program at Virginia Tech are:

- graduates with a commitment to learning and advocacy for all students
- a faculty devoted to improving education through research, teaching, and outreach
- an emphasis on science, math, and technology within a comprehensive School of Education
- graduates with expertise in content fields and related pedagogical knowledge and skills
- committed clinical supervisors in schools
- field experiences and internships in diverse school settings
- the latest instructional technologies
- a strong demand for our graduates

Applications for School of Education programs may be submitted on line through the Graduate School website: **www.graduateschool.vt.edu**.

Undergraduate Courses of Study

Undergraduate courses of study leading to bachelor's degrees at Virginia Tech are listed below. In addition, many options and specialties pertaining to each academic college are described in the individual **college sections** in this catalog.

College of Agriculture and Life Sciences

Agribusiness
Agricultural Sciences
Agricultural Technology
Animal and Poultry Sciences
Applied Economic Management
Biochemistry
Crop and Soil Sciences
Dairy Science
Environmental Horticulture
Environmental Science
Food Science and Technology
Human Nutrition, Foods, and Exercise
Landscape Horticulture and Design

College of Architecture and Urban Studies

Architecture
Art
Building Construction
Environmental Policy and Planning
Industrial Design
Interior Design
Landscape Architecture
Public and Urban Affairs
Smart and Sustainable Cities

College of Engineering

Aerospace Engineering
Biological Systems Engineering
Chemical Engineering
Chip Scale Integration
Civil Engineering
Communications & Networking
Computer Engineering
Computer Science
Construction Engineering and Management
Controls, Robotics, & Autonomy
Electrical Engineering
Energy & Power Electronics Systems
Engineering Science and Mechanics
Industrial and Systems Engineering
Machine Learning
Materials Science and Engineering
Mechanical Engineering
Micro/Nano Systems
Mining Engineering
Netowrking & Cybersecurity
Ocean Engineering
Phototonics

Radio Frequency and Microwave
Space Systems
Software Systems

College of Liberal Arts and Human Sciences

Cinema
Childhood Pre-Education
Classical Studies
Communication Studies
Consumer Studies
Creative Writing
Criminology
English
Family and Consumer Sciences
Fashion Merchandising and Design
French
German
History
Human Development
Humanities, Science, and Environment
International Public Policy
International Relations
International Studies
Literature and Language
Multimedia Journalism
Music
National Security and Foreign Affairs
Philosophy
Philosophy, Politics, and Economics
Political Science
Professional and Technical Writing
Property Management
Public Relations
Religion & Culture
Residential Environments & Design
Russian
Sociology
Spanish
Theatre Arts

Pamplin College of Business

Accounting and Information Systems
Business Information Technology
Economics
Finance
Hospitality and Tourism Management
Management
Marketing Management
Real Estate

College of Natural Resources and Environment

Environmental Informatics
Environmental Resources Management
Fish Conservation

Forestry
Geography
Meteorology
Natural Resources Conservation
Packaging Systems and Design
Sustainable Biomaterials
Water: Resources, Policy, and Management
Wildlife Conservation

College of Science

Biochemistry
Biological Sciences
Chemistry
Clinical Neuroscience
Cognitive and Behavioral Neuroscience
Computational and Systems Neuroscience
Computational Modeling and Data Analytics
Economics
Experimental Neuroscience
Geosciences
Mathematics
Microbiology
Nanomedicine
Nanoscience
Physics
Psychology
Statistics
Systems Biology

University Enrollment and Academic Progress

Registration Procedures

1. Registration for continuing students is an eight-day period (Course Request) in the middle of each semester during which currently enrolled students may request classes for the next semester. Students register for summer school (if they plan to attend) beginning in December. Students register for fall semester during spring semester.
    a. Students should consult their completed Pathways Planner and review it with their departmental advisor. Both should be aware of such considerations as the student's current GPA, the course load in hours and in effort required, pre- and co-requisites for courses so limited, the student's relationship to the eligibility schedule, and fulfillment of Curriculum for Liberal Education (Pathways) requirements and those for major, minor, or cognate. If the student fails to meet with their advisor, a **hold** may be placed on their registration.
    b. When a schedule is designed, the student utilizes the course request module in Hokie SPA to enter the course requests.
    c. Prerequisite checking is enforced by some departments. The registration system will review the student's academic history to determine compliance with any prerequisites.
    d. **Overloads** (more than 19 hours per semester, seven each summer session, or six for winter session) require permission of the student's academic dean. The student will be scheduled for the first available 19 hours (seven in summer and six in winter) requested.
    e. Every student must annually provide an up-to-date local address, an emergency contact, opt in/opt out of the VT Alerts system and all students must acknowledge the continuing

duty to report arrests and convictions to the University. Students are prohibited from registration until the requirements are updated in the student record system.

f. The student's **current class schedule** may be printed by accessing Hokie SPA; the student is then responsible for verifying that they are in fact enrolled in the courses and sections they have been attending.

2. Approximately three weeks after the close of registration week, course request results are available and may be accessed through Hokie SPA. The web class ticket will include detailed information regarding sections which are full, conflicting, withdrawn, or restricted which explains why these sections were not added to the student's schedule. See item number six (6) below for details about why a student's course selections are sometimes ignored, or why a student's schedule might be purged or held from registration.
3. Students may adjust their schedules on a space available basis using web drop/add, an electronic schedule adjustment program. Students should consult with their advisors before making any changes except those for convenience (usually time). 1000-level Mathematics and English courses, because of the high demand, currently have restrictions on section changes. As a rule, any student who drops a 1000-level English or Math course via Hokie SPA or department will not be allowed to force-add another 1000-level English or Math course that term. A student should be aware that dropping below full-time status (12 semester hours) may jeopardize financial aid, campus housing, and degree completion. Some courses may drop students for failing to attend the first class. Refer to the comments section of the course in the *Timetable of Classes*.
4. A **Force-Add** form permits admission to a class **over** the desired enrollment threshold, but not over room capacity. This request is submitted via a "force-add" form **available in the department offering the course**, and requires the instructor's (or, in some departments, departmental) permission. **Requests for force-adds are processed by the department offering the course. Caution: The force-add transaction permits enrollment in courses with conflicting times**.
5. Responsibility for **Payment of Tuition and Fees**: all students who initiate enrollment either by course request or by drop/add are responsible for the payment of assessed tuition and fees. Only the submission of an official withdrawal or resignation removes the student from any applicble fee responsibility. Failure to attend class(es) or to submit appropriate university paperwork is not a justifiable reason for removal of assessed fees retroactively.
6. **Late Adds and Drops Adjustments** to a student's schedule after the last date to carry out a specific transaction (see Hokie SPA for deadline dates) require permission of their own academic dean. Thus, a Business major wishing to late-drop an English course requires approval from the College of Business, not that of Liberal Arts and Human Sciences. A late-drop request based on mental or physical illness requires a recommendation from Schiffert Health Center and/or Cook Counseling Center. Faculty cannot add or drop students from their rosters.
7. **Purged and Held Registrations** Failure to pay tuition bills by a posted deadline (usually by the end of the second week of classes) may result in the student's schedule being **purged** (removed from the system). A schedule may be **held** (made inaccessible to department staff, as well as to students using drop/add, thereby precluding transactions of any type) for nonpayment of fees other than tuition (e.g., parking tickets), for Honor Code or Student Conduct violations, for academic ineligibility (due to department and/or academic suspension), or for failure to make progress toward a degree. This last hold is imposed by the student's dean, while all other holds are imposed by other offices. The student should check with the office imposing the hold, as only that office is authorized to remove the hold. **The Office of the University Bursar processes all billing for tuition and fees; contact the Office of the Bursar if you have questions about your bill or do not receive a bill**.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Grades, Grade Points, and Credit Hours

AP, IB, Cambridge Exam

Virginia Tech awards AP, IB, Cambridge Exam equivalencies after faculty review of content and applicable Virginia Tech credit. In accordance with state policy, Virginia Tech accepts credit from **Advanced Placement**, **International Baccalaureate,** and Cambridge Exam based on annual faculty and university program review.

College Level Examination Program (CLEP)

CLEP is a national program that offers students credit by computer-based examination. This allows students to have the opportunity to obtain recognition for achievement in specific college courses. Students should request their official CLEP exam results directly from the College Board at: **www.collegeboard.com**. Virginia Tech's CLEP school code is 5859. Once awarded CLEP credit can be viewed on Hokie SPA under the grades menu. A maximum of 12 credit hours may be awarded.

Refer to the Office of the University Registrar's website at **https://registrar.vt.edu/Advanced-Standing-Transferable-Credit.html** for information and to view the CLEP Credit Table. Questions about CLEP credit should be directed to the Office of the University Registrar at **transfercredit@vt.edu**.

Credit by Examination

Credit may be allowed by special examination where command of a subject can be demonstrated in place of formal course work. Credit by Exam is not available to a student who has previously audited or enrolled in the course or has previously attempted credit by examination for the course. Only currently enrolled undergraduate students are eligible for special examinations. If credit by examination is approved, the offering department shall have full responsibility for determining the type of examination to be given and what constitutes a passing grade. A maximum of 12 hours may be awarded. Approval must be obtained from the head of the department offering the course.

Credit established by examination may not be used to satisfy the in-residence requirements for graduation. No grades or quality credits will be assigned. Credit by exam is graded on a Pass/Fail basis only.

There is a $10.00 per credit hour fee for the examination. Fees are subject to change at the beginning of an academic year.

Credit for ROTC Courses

In some majors, not all ROTC courses may be applied toward a bachelor's degree. Students should consult their approved major checksheet for specific information on which courses will count toward their degree.

Credit Hour System

Virginia Tech uses the credit-hour as its unit of credit in the semester calendar system. Course descriptions under the departments of instruction (in the chapters on the various colleges) indicate the number of credits received per term.

Dean's List

Undergraduate students who attempt at least 12 credit hours with all credits graded on the A-F option and who earn a 3.4 GPA for either spring or fall semester will be included on the Dean's List for that term. The Deans' Lists are not compiled for summer sessions. Any notifications or certificates indicating inclusion on the Dean's List for a particular term are issued by the student's academic dean.

Examinations and Re-Examinations

The final examination enables a student to demonstrate their command of the subject and provides the faculty member an opportunity to review student performance and the character and quality of the course. Final examinations are held at the close of each term according to a schedule established by the university. An instructor may not change the date or time of a final exam without the approval of the dean of the college. Students may request permission from their college dean to reschedule a final exam if they have conflicting exams or if they have three final exams in 24 hours. Otherwise, permission to reschedule a final exam is granted by the dean only in very unusual circumstances. Students who are unable to take an examination due to illness or circumstances beyond their control may reschedule the examination. Deferred final exams must be authorized only by the student's academic dean or by Schiffert Health Center.

Students are entitled to review their graded examination papers. Failure to take an examination yields a zero grade for the examination, weighted as specified in the course statement on grading criteria. The faculty member administers and grades the exminations.

Re-examination of one final exam is available only for students who are candidates for degree in the same

term as the final exam.

After a term is over, a re-examination in one course in which the final grade earned is C- or below may be authorized if the student was enrolled in the course during the final term of his or her senior year and if a satisfactory re-examination in the course will qualify the student for graduation. The student must make the re-examination request to the dean and must complete the exam as soon as possible after the first examination.

For the student to be granted a re-examination, approval is required by the instructor, the student's department head, and the student's academic dean. In determining the validity of the student's request, consideration is given to class performance and completion of assigned work. The University Registrar provides verification of compliance with the requirements of this policy.

Grade Appeal Procedure

As Per University policy, the assignment of a grade is the sole prerogative of the instructor of the class. It is incumbent on the instructor to establish the criteria for grading in the syllabus that is distributed at the beginning of the term. All grades are to be based on established grading criteria and not on personal conduct or opinions unrelated to academic standards. An individual student may not do extra work to raise his/her grade. If a student feels that a grade has been calculated incorrectly or has been assigned in a prejudiced or capricious manner, the student should discuss the matter with the instructor. If discussion between the instructor and the student cannot resolve the issue, the student should appeal to the department/division head/director. In the unusual circumstance that resolution does not occur at the departmental/divisional level, the student may appeal to the college dean of the course who will attempt to reconcile the matter by whatever mechanism seems most appropriate for that college and for that case. A grade appeal must be made by the student, and as soon as possible but no later than the end of the student's subsequent term of enrollment after the grade in question has been assigned.

Grades and Grade Points

The academic achievement of a student in a specific course is rated as follows:

Letter Grade	Grade Points for each hour
A (Excellent)	4.0
A-	3.7
B+	3.3
B (Good)	3.0
B-	2.7
C+	2.3
C (Fair)	2.0
C-	1.7
D+	1.3
D	1.0
D- (Barely Passing)	0.7
F (Failure)	0.0
I (Incomplete)	---
NG (No Grade)	---
NR (Not Reported)	---
P (Passing)	---
RP (Repeated Course)	---
S (Satisfactory/credits only)	---

- A grade of "I" (incomplete) may be given when the requirements of a course other than the final examination have not been completed due to illness or extenuating circumstances beyond the student's control. The "I" grade is the prerogative of the instructor.
- To remove an "I" grade, lecture course requirements must be satisfied during the student's first subsequent term of enrollment, and laboratory course requirements must be satisfied prior to the end of the first term during which the course is offered and the student is enrolled. Incomplete and "X" grades are automatically converted to "F" if requirements are not fully satisfied during the period of time allowed.
- An "NR" grade is assigned automatically by the system in the event that a faculty member does not submit a grade by the grade entry deadline. An "NR" grade will not be calculated as an "F" in the student's GPA and will not be converted to an "F" at a later time. The "NG" is intended to be a grade distinguishable from those initially assigned by the instructor and thus to indicate clearly the origin of the grade.
- ”W” Grade: Courses from which a student withdraws under the terms of the policy, will appear on their transcript with a "W" grade, but will not count in the GPA hours nor in any GPA calculations. The "W" signifies that this policy was invoked and

W (Course Withdrawn)	---	does not reflect the rationale for its use. The reasons for use remain the student's purview. • Grade Point Average (GPA) is computed by dividing the total number of quality credits earned by the total number of hours attempted at Virginia Tech, except courses passed on a Pass/Fail basis and courses with an "X" (Continuing Course). "NG" grades are computed as "F" grades in determining GPA. The GPA is unaffected by the "I" grade, unless or until the "I" is converted to an "F" for failure to complete the course requirements within the allotted time. All courses repeated count in the calculation of the grade point average unless changed to Pass/Fail per policy. • Repeated Courses: A student may not repeat courses in order to improve his or her grade average where a grade of "C or higher has been earned. An assigned grade of "A-D" for the second occurrence will be changed to a grade of "P" whenever a graduation analysis (DARS report) detects a repeated course with a "C" or better grade. Repeating a course where the course is "C-" or below, both instances of the graded course will be computed in the grade point average.
X (Continuing Course)	---	

Grades (Midterm)

Midterm grades are produced for freshmen and transfer students whose first term of enrollment is fall semester. Beginning Fall 1996, students whose first term of enrollment is summer will also receive a midterm grade report during fall semester. "Satisfactory" is given for work earning a grade of C or better and "unsatisfactory" is given for work earning a grade of C- or below. The midterm grade is not part of the student's permanent academic record and is only intended to be an early indication of the student's progress.

Graduation Requirements (Grade Hours Passed or Completed)

The "total credits" figure on the displayed grade report is not necessarily the same as the total hours (often referenced as hours passed) required for completion of the degree (not all credit hours are effective toward graduation requirements). Students are responsible for verifying required hours for completion by reviewing their degree analysis (DARS) with their advisor.

Listed below are a few examples of typical situations yielding "pass" hours which must be subtracted to determine the total credits useful toward graduation requirements:

- Transfer and/or advanced placement credits that have been subsequently duplicated by courses at Virginia Tech.
- Credits earned at Virginia Tech that have been duplicated by repeating courses or taking courses ruled to have duplicating credit.
- Transfer credits allowed from a two-year college that are in excess of one-half of the total credit hour requirement for the curriculum.
- Credits for **Physical Education Service Activities** courses (now listed under HNFE), which exceed a total of two, the maximum allowed toward a bachelor's degree.
- Credits for military science that exceed the total specified by the college for the student's curriculum.
- Credits on the pass/fail grading system that exceed 12 credit hours allowable exclusive of pass/fall only courses.
- Credits for courses that do not count towards the degree, (e.g. UNIV 1004 College Success Strategies)..

Obsolete Academic Records

Students previously enrolled at Virginia Tech that have not completed their degree may wish to return to complete their degree with an expanded knowledge not refelcted in their earlier records. If a student returns to the university after an absence of at least five years they may request in writing to have their academic records evaluated by the appropriate academic dean. Such transcripts will be evaluated in the same manner that transfer student transcripts are considered; credits will be allowed only for those courses appropriate for the degree. The grades for these allowable courses will not be factored into the student's GPA, but all courses will remain part of the student's permanent record. The permanent record will be posted with appropriate comment regarding the revaluing of the obsolete records.

Pass/Fail Grading System

A limited pass/fail (P/F) grading system is available to encourage students to enrich their academic programs and explore more challenging courses outside their majors, without the pressures and demands of the regular grading system. The P/F grading option is available to all undergraduates who have completed a minimum of 30 credit hours at Virginia Tech and have a cumulative GPA of 2.0 or above. These restrictions do not apply to courses that are only offered P/F. **No required course or course used for the Pathways General Education may be taken on a "P/F" basis (unless only offered on a P/F basis).**

Under the pass/fail system students are allowed to attempt twelve (12) credit hours in their degree program on a pass/fail basis exclusive of courses only offered pass/fail. Students enrolled in five-year designated programs (College of Architecture and Urban Studies) may attempt twelve (12) credit hours or ten percent of the total hours required for the degree whichever is greater. Courses offered pass/fail only are not included in the twelve total hours allowable under the pass/fail system. Additional degree programs may not be used to increase the number of pass/fail credits that a student is permitted to use toward any degree. No more than two courses per term may be taken P/F, excluding physical education activity courses and required courses offered on a P/F basis only.

Under the P/F grading system, a "P" is granted for earning a "D" or better in the course; otherwise, an "F" is given. A "D-" is a failing grade under the P/F option. The "P" or "F" is recorded on the student's transcript and credit is given if the course is passed. If the course is failed, the "F" is considered equivalent to an "F" received under the "A-F" grading system and is included in calculation of the grade point average (GPA). Once credit is received for a course taken under the P/F system, the course cannot be repeated under the "A-F" grading system.

Any course to be taken under the P/F option should be designated as such upon request for the course. The student may change grading options to P/F until the drop deadline and to A-F until the deadline for resigning without penalty.

Repeat Course Policy

Beginning Fall 2016 students may only attempt a course three times. An "attempt" is when a student is enrolled in a course on the last day to add courses during each semester. Courses designated as repeatable credit (to the limit allowed) are excluded from this policy (e.g. independent studies, internships, etc.).

All course repeats should be done in consultation with a student's academic advisor. Any student who enrolls for a fourth attempt will be dropped from the course. If a student's extenuating circumstances prevent successful completion of the course on a third attempt, the student may appeal (petition) to repeat the course again. For more information regarding the appeals process, please refer to your academic dean's office.

Repeating a course subsequent times may affect financial aid and eligibility for certain programs. Students receiving financial aid should check with University Scholarships and Financial Aid to determine what, if any, financial aid implications there are for repeating courses. Veterans, athletes and international students may have additional rules associated with course repeats. Check with the appropriate department for additional

information.

Study Week

Study week refers to the last three calendar days of classes for each semester. All written work, with the exceptions noted below, should be assigned so that it can be graded and returned during a regularly scheduled class meeting of the term. In-class hour-long examinations or other major in-class written assignments or tests shall not be given during study week. The exceptions for undergraduate courses are:

- Dates for turning in term papers and project reports may be set at the discretion of the instructor, provided that the student is not to be held responsible on the final examination for the subject matter therein.
- In laboratory courses or other courses that do not warrant a final examination during the examination period, an examination, if required by the department and/or instructor, may be given during the last regularly scheduled laboratory or class period.
- Regularly scheduled final examinations, when special permission has been granted by the dean of the appropriate college.

Graduate courses also have specific exceptions which may differ from those for undergraduate courses. Contact the Graduate School for details.

Transfer Credits

Enrolled students in good standing (academic and conduct) at Virginia Tech must receive pre-approval from their academic dean's office to transfer credit to Virginia Tech. Pre-approval from the academic dean does not guarantee transfer of the course if the student has duplicate credit in the approved course. Students must review their degree requirements by reviewing their degree audits in HokieSpa to ensure credits will apply to their degrees. Students who have been placed on academic or judicial suspension by the University are not eligible to transfer credit for terms of enrollment that coincide with their suspension term(s).

The rules below govern the transfer of credit on a university level. Some colleges at Virginia Tech have additional policies and procedures regarding transfer credit. Students are responsible for consulting with the academic dean's office in the appropriate college to discuss their plans to transfer credit, and to request information on the college's specific policies and procedures regarding transfer.

- Courses for transfer must be taken at a regionally accredited college or university.
- Courses must be college level, not courses only leading to a vocational program.
- Only courses with a "C" grade or better will transfer. Note: A "C-" will **not** transfer.
- Credits will **not** transfer for students who are classified as non-degree-seeking students.
- Course equivalencies will be determined by the Office of the University Registrar in partnership with Virginia Tech faculty.
- Credit hours transfer; grades do not transfer.
- No more than 50% of VT bachelor degree requirements may transfer from any community college including the Virginia Community College System (VCCS).
- Of the last 45 semester hours before graduation, a maximum of 18 semester hours may be transfer hours.
- Many colleges and universities will require a letter of good standing from Virginia Tech before they will enroll a student from another university who wishes to transfer credits back. Virginia Tech students can request this letter certifying their good standing by completing a "Request for Certification" form in the Office of the University Registrar.
- Upon completion of the course(s) and posting of grades, students are responsible for requesting that an official transcript be sent directly to the Office of the University Registrar at Virginia Tech as soon as possible, but not later than two semesters after the work is completed.

"W" Grade Policy

The policy is intended to assist undergraduate students who find themselves enrolled in undergraduate level courses for which they are insufficiently prepared, or for those who initially enroll in majors that they subsequently change. This policy allows currently enrolled students to designate a grading option of "CW" to a course. Courses with this option are not gradable but remain on the academic transcript with the letter grade of "W". A maximum of three (3) courses (regardless of credit) may be dropped beyond the normal six-week drop deadline date during a student's undergraduate academic career at Virginia Tech subject to the following stipulations:

- Students must formally request to apply the W Grade option to a course by the last day of classes of each term. The deadline appears in the Academic Calendar, previously the Timetable Calendar.
- Courses with the new grade mode of "W" will appear on the transcript with a "W" grade and will continue to count toward hours enrolled for purposes of financial aid and tuition assessment, but will not count in the GPA hours nor in any GPA calculations. The "W" signifies that this policy was invoked and does not reflect the rationale for its use. The reasons for use remains the student's purview.
- There are no refunds of tuition and fees as a result of application of the policy. However, utilization of this grade option policy may affect Reasonable Academic Policy requirements for continued receipt of federal financial aid. Students are urged to consult with their financial aid advisor.
- A student decision to invoke this policy is irrevocable and unappealable.
- Application of the W grade option may not be employed to reduce or obviate any penalty otherwise accruing to students under the University Honor System. Previously processed W grade options will be voided if the course is penalized per an Honor System action.
- Students may request a W grade option change for any course, irrespective of the evaluation earned in it up to the point of their request for withdrawal. However, if a registration hold exists at the time of application of this policy, the student must take action to remove the hold within five (5) working days of the application or the request will be voided. Students are responsible for resolving their registration holds with the appropriate university office.
- Students already enrolled when this policy takes effect who have exercised their option to use the previously existing Freshman Rule shall not be eligible to use this policy.

To exercise this option, interested students should see their academic advisor to obtain a course withdrawal form and submit it to their designated departmental representative and academic dean for approval.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

University Policies Governing Enrollment

Appeals

Under extenuating circumstances, the student's academic dean may present, on behalf of the student, appeals for re-admission and other exceptions to academic eligibility policies to the Virginia Tech Academic Appeals Committee. Students presenting appeals based on medical reasons must request recommendations from the Student Health Evaluation Committee. Students may appeal other academic decisions made by their college associate dean to the college dean.

Auditing Courses

A student may enroll as an auditor in any class other than laboratory classes and studio courses, with the permission of both their academic advisor and the class instructor. The lecture portion of laboratory-linked courses and courses with computation periods may be designated as eligible for audit at the request of the academic department head (of the course in question) and on the approval of the student's academic dean. Auditors may not add or drop an audit option after the last day to enter classes. Students will not be allowed to register for credit in any course previously audited. Audit is a mechanism for a student to reserve a seat in a course, with no performance evaluation of the student. Students may not unofficially attend class(es). If the

student or faculty expect evaluation of coursework, then the student must enroll either as a P/F option or for a letter grade. If a faculty member wishes to restrict the participation of auditing students in selected activities, then that should be stated in the syllabus.

Class Level

A student must have received credit for at least 30 hours to be classified as a sophomore, at least 60 hours to be classified as a junior, and at least 90 hours to be classified as a senior.

Course Prerequisites (University Policy)

Many course offering departments enforce prerequisite checking at registration. The automated system checks the student's academic history and/or current enrollment for verification of compliance. Students without the required prerequisite will be prohibited from enrolling. On occasion, students are permitted to take courses without having the specified prerequisites only upon obtaining the consent of the instructor. Students who enroll in a course for which they clearly have not satisfied the prerequisites or equivalent or obtained the appropriate permission may be dropped from the course. Deliberately false statements testifying to the satisfaction of prerequisites constitute a violation of the honor code. Students have the right to appeal a decision about prerequisites to the head of the department offering a course. Students should recognize that 3000 and 4000 level courses assume a certain level of academic maturity and general background regardless of the stated prerequisites. The course instructor can be consulted regarding the implications of this expectation for a specific course.

Enrollment (Semester Hour)

Minimum full-time enrollment for undergraduate and associate degree students is 12 hours per semester in regular A-F option or P/F option. For each summer session, the minimum is 5 hours. Audit hours are not used in establishing minimum full-time enrollments.

Full-time enrollment for graduate students is 9 hours or more in regular A-F option, P/F option, or equivalent credit. For each summer term, the minimum is 3 hours. Neither the payment of full fees nor compliance with maximums established as a condition of employment or appointment is a basis for deviation from the definition above.

Graduation with Distinction

Graduating with distinction is an honor bestowed on those who earn a 3.4 or higher and who complete no less than 60 hours at Virginia Tech. Distinction is denoted on the diploma and on the transcript. Levels of distinction are:

- Students with a cumulative GPA of 3.8 or greater are graduated ***Summa Cum Laude***.
- Students with a cumulative GPA of 3.6-3.7999 are graduated ***Magna Cum Laude***.
- Students with a cumulative GPA of 3.4-3.5999 are graduated ***Cum Laude***.

Grade Point Averages are not rounded in qualifying a student for distinction. In computing eligibility for graduation with distinction, only undergraduate level work attempted at Virginia Tech will be used. Students may not use hours earned at Virginia Tech as an associate, professional, or graduate level as part of the 60 semester hours required to earn distinction. The notation of distinction on the diploma and on the transcript is independent of the notation of a degree in honors, if applicable. (See section on "**The Honors Program**" for information about graduating *in honors*.)

Limits on Acceptable Credits for Degrees

Not more than 6 credit hours earned from extension courses, radio courses, television courses, and intensive courses (e.g. taken while in active military service, etc.) will be accepted for undergraduate degree credit.

Thirty-eight hours of advanced placement credit and/or international baccalaureate and/or Cambridge International Examination credit may be accepted towards the undergraduate degree.

Readmission through University Registrar or Academic Dean

Formerly enrolled students who have greater than the 2.0 GPA overall may seek readmission via web course request form if they are eligible to return. Students returning from academic suspension should consult their academic dean's office for readmission procedures. (These procedures vary from college to college within the university.)

Formerly enrolled students, not in good academic standing who stop enrollment or resign for personal reasons, and later complete course work at another college or university are required to submit their transfer transcripts to certify good standing at all institutions.

Academic standing and student conduct at other institutions are considered in the deliberation for approval for readmission.

Formerly enrolled students in good academic standing who resign for personal reasons, do not continue enrollment at Virginia Tech, and later complete course work at another college or university are required to submit their transfer transcripts to their academic dean prior to or during their first term of re-enrollment.

Registration Requirements

Demographic Information: Virginia Tech policy requires annually the collection of specific demographic data for each student: emergency contact entry or emergency contact confirmation, and VT alerts Opt In or Opt Out action.

Local Mailing Address: Virginia Tech policy requires the updating of a student's local mailing address to reflect the local residential address while enrolled in school.

Conduct Policy: Students must annually acknowledge the Virginia Tech's Student Conduct policy on Arrests and Convictions. The University enacted policy requiring all students, regardless of academic level or campus, to report any arrests, convictions, and/or protective orders to the university.

VT Alerts: Students must opt in or opt out of the Virginia Tech alert system annually.

Students will be prohibited from registration until the above information is provided.

Missing Person Contact: Student(s) may denote a specific third party as emergency contact as primary in cases of missing person(s). Visit Hokie SPA, choose the Hokie Plus menu, add 'new emergency contact'. In the pull down selection for relationships, choose « Missing Persons Contact ». In the case of such an emergency, the university will first contact the missing person designee before any alternate emergency contact(s).

Resignations

A student may resign without academic penalty by completing an official Virginia Tech resignation form on or before the published resignation deadline for each term. The student can request this resignation form from either the University Registrar's Office, the University Registrar's website, or the academic Dean's Office. The student's grade report and permanent record will show that he/she was enrolled for the term and that he/she resigned on the specific effective date.

A student who resigns after the stated deadline without written authorization for resignation-without-penalty by the respective academic dean will receive automatic "F" grades in all courses in which the student is enrolled. The transcript will carry the notation, "Suspended by committee action for unauthorized resignation," and the

hours for which "F" grades were received will be included in the cumulative GPA for both academic eligibility and graduation requirements.

In the case of authorized resignations after the deadline, grades will not be assigned, and the academic dean will determine the student's academic status (whether or not he/she is eligible to return) based on the student's previous record.

Satisfactory Progress

University policy requires that all students meet the following minimum criteria to be certified as making satisfactory progress toward a degree.

- Have an overall grade point average at or above that specified in the academic eligibility schedule (determined at the end of the Spring semester).
- Upon having attempted 36 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must have passed at least 12 semester credits of Pathways for General Education requirements.
- Upon having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, freshman rule hours), students must:
    - have passed at least 24 semester credits of Pathways for General Education requirements
    - be enrolled in a degree-granting program and
    - be certified at the close of the academic year by their department as making satisfactory progress toward a degree, based upon pre-established minimum criteria from departmental checksheets.
- Upon having attempted 96 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must have an in-major grade point average of 2.0 or above.

Colleges and departments may impose additional requirements. It is the student's responsibility to become familiar with the requirements of his or her college.

Transfer Work while on Suspension

A student may not receive credit for course work taken at another college or university during any period in which the student has been placed on suspension by Virginia Tech for academic or disciplinary reasons.

Undergraduate taking Graduate Courses

Undergraduate students may enroll in graduate-level course work in the senior year, provided they have an overall GPA of 3.0 or above and the written approval of the department head and the Graduate School. To enroll in graduate-level course work, the undergraduate student must apply to the Graduate School as a dual registrant. Each term that a student is dually enrolled, he or she must fill out a form in the University Registrar's Office to indicate which courses are being counted for undergraduate credit and which for graduate credit. If graduate courses are used to satisfy undergraduate degree requirements, they cannot be used to satisfy any advanced degree requirements at Virginia Tech. Students may not concurrently have dual status while enrolled in an Undergraduate Dual status.

Graduate courses may not be taken without prior written approval from the Graduate School.

Accelerated Undergraduate/Graduate Degree status

High achieving and talented seniors may apply for Accelerated status. The minimum admission requirements are:

- An advisor for the proposed accelerated program
- Listing of courses for use on the plan of study

- Minimum grade point average of 3.3
- Some programs may include additional requirements

The Accelerated Undergraduate/Graduate Degree status allows students with specific qualifications to allow certain courses to count toward both the undergraduate and graduate degree:

- No more than twelve (12) credit hours may be used.
- All courses must be at the 4000 level or higher.
- No more than six (6) credit hours may be used at the 4000 level.
- A grade of B or higher must be earned in each course. No courses may be taken pass/fail.

125 Percent Rule for In-State Tuition

The Code of Virginia establishes rules for eligibility for in-state tuition for all students enrolled at public institutions in the Commonwealth of Virginia. Section 23-7.4:F of the Code of Virginia further requires undergraduate students to maintain progress toward the degree to comply with continued eligibility for in-state tuition. Students with entry dates Fall 2006 and after may not exceed attempted hours that total 125% of the minimum credit hours needed for a specific degree program and retain in-state tuition eligibility. Students exceeding 125% will be assessed a surcharge for each semester of continued enrollment after exceeding the credit hour threshold. For the purpose of this state law, all credits attempted (Virginia Tech and Transfer) are used in the calculation of the percentage. The requirement does allow the subtraction of credits awarded for Advanced Placement, Advanced Standing, International Baccalaureate, and Credit by Exam from the attempted totals. Important resources to assist you so as to avoid the credit hour surcharge are:

- Undergraduate Degree Hours and 125% Tuition Credit Hour Threshold Table (**http://www.registrar.vt.edu/academic_records/in-state/125-percent-table.html**)
- Credit Hour Surcharge Costs, Virginia Tech Bursar (**http://www.bursar.vt.edu/tuition**)
  Click on "surcharge" link. Please note that the Excess Credit Hour Tuition surcharge is per credit hour. To calculate the total surcharge for a term, multiply the surcharge amount per credit hour by the number of credit hours enrolled (up to 12 credit hours per semester; 5 credit hours per summer term).
- **State Code of Virginia, Section 23-7.4:F**

Students with declared second majors and minors: the total credits additional required for earning of the second degree and/or minor will be added to the total prior to computing the 125 percentage. For example, as student's first degree requires 120 hours. The second degree requires 30 additional hours. The 125% will be computed based on 150 hours.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Admissions Information

Academic Credentials

Academic preparation for admission to Virginia Tech is best achieved by sustaining an academically rigorous course selection throughout high school. Specifically, it is recommended that a minimum of seven (7) academic units be completed during the last two years of high school with at least three (3) academic units completed each year in the most rigorous academic programs available.

Each application is evaluated holistically to include a student's academic performance combined with personal attributes. Primary criteria used for holistic review include rigor of academic course selection, grades in academic courses, and standardized test (SAT or ACT) performance. Other criteria include, but are not limited to, personal strengths such as overcoming adversity, leadership appointments, and athletic accomplishments.

Considerations are also given to applicants who apply as a dependent of alumni of Virginia Tech, special talents, first-generation college attendee, interest in the Virginia Tech Corps of Cadets, legacy, major, ethnicity, residency, disciplinary record, and veteran status. Recommendation letters will not be considered for admissions review. For the 2017 fall semester, those offered admission had a middle 50th percentile of GPAs of 3.78-4.23 and a middle 50th percentile of combined SATs (critical reading and math) of 1160-1340. Competitive freshman applicants will have A/B grades in a rigorous curriculum and strong SAT or ACT scores.

Students who intend to compete in intercollegiate athletics are also required to meet all NCAA and ACC requirements for admission.

Prospective music students must schedule an audition with the music department. Applicants who wish to request an audition should contact the department head by January 1 of the senior year in high school.

Admission (Undergraduate)

Prospective students and their families are welcome to visit the campus any time the university is in session. The Office of Undergraduate Admissions is open Monday-Friday from 8:00 a.m. to 5:00 p.m. and on many Saturdays from 8:30 a.m. to noon. Admission information sessions and student-led walking tours are offered regularly; reservations should be made in the 'Visit Virginia Tech' section at **https://vt.edu/admissions** for up-to-date schedule information. Virginia Tech neither requires nor schedules personal interviews for undergraduate admission.

Information on undergraduate admission may be obtained by contacting:

Office of Undergraduate Admissions
Virginia Tech
Blacksburg VA 24061
Phone: 540-231-6267
Fax: 540-231-3242
E-mail: **admissions@vt.edu**
Web: **https://vt.edu/admissions**

Admission (Freshman Process)

When applying for admission as a freshman, the applicant must send the following materials to the Office of Undergraduate Admissions prior to the deadlines:

1. Official online application and application fee (non-refundable): $60 for freshmen, transfer, and non-degree students; $70 for international students.

   Please note: *we expect students to apply online at* ***https://vt.edu/admissions****.*

2. Applicants are required to submit self-reported grades and test scores through the online application process.
3. A final official transcript is requested after admission is offered and the student accepts the offer.
4. Discharge certificate (DD214) if the applicant is a veteran.
5. Domicile supporting documents if the student is requesting in-state status.

An **Early Decision Option** is available for students with strong qualifications who are committed to attend Virginia Tech. Those interested in Early Decision must choose that option on the application form and submit all required credentials by November 1. All Early Decision applicants are notified of their admission status by December 15. Early Decision applicants may be offered admission, deferred to the regular applicant pool, or denied admission. Applicants deferred to the regular decision pool will receive unbiased consideration during this admission process. Early Decision is a binding agreement in which applicants agree to apply only to Virginia Tech under an Early Decision option and, if offered admission, submit the matriculation deposit by January 15. This does not mean that Early Decision applicants cannot apply to other institutions as regular-

decision applicants, but rather that Virginia Tech is their first choice and, if offered admission under Early Decision, they will withdraw applications to other institutions, and accept the Virginia Tech offer.

An Early Action option is available to applicants starting Fall 2018. This offering is designed for students who seek an early admissions decision that is not binding. The deadline for Early Action application is December 1. Notification of admissions decision for this group is by February 22. The applicant will have until the National deadline of May 1 to notify Virginia Tech of their decision to accept or decline their admission offer.

Freshman applicants applying for Regular Decision must submit a completed application by January 15 and will receive a notification of the admission decision by March 5. If offered admission, the applicant will receive an official offer letter, instructions to apply online for housing, and instructions to download the state-required health history form. Virginia Tech subscribes to the National Candidate's Reply Date of May 1 for freshmen offered admission for the fall semester.

Admission (International Applicants)

International applicants for undergraduate admission are generally considered out-of-state students for tuition purposes and should apply using the Application for International Admission. International student applicants must complete the following courses: 3 units of math (includes algebra, geometry, and algebra II), 2 units of laboratory science (choose from biology, chemistry, or physics), and additional academic units (foreign language is highly recommended).

International freshman applicants are not required to submit SAT or ACT scores. In addition, international students whose native language is not English must document proficiency in the English language by submitting a TOEFL (Test of English as a Foreign Language) score or IELTS (International English Language Testing System) score. Official copies of all scores must be submitted to the Office of Undergraduate Admissions.

The TOEFL or IELTS is required of all applicants who are not native speakers of English, in addition to all foreign students with visas, except those raised or schooled in Australia, Canada, Great Britain, Ireland, Jamaica, or other countries in which English is the language of instruction. A TOEFL score of at least 80 (with no subscore below 20) on the Internet-based test is expected. Students taking the IELTS are expected to obtain a score of at least 6.5 to be considered for admission to Virginia Tech. Achieving these scores is no guarantee of admission. Transfer applicants who have completed two semesters or terms of a non-ESL English composition course with above-average grades at an accredited U.S.-based college or university are not required to submit TOEFL or IELTS scores.<

Non-English transcripts and documents must be submitted in their original form, accompanied by a certified English translation. Unofficial documents and documents without accompanying English translations will not be accepted.

All university-level work completed outside the United States must be evaluated by a professional educational credential evaluation service. (A listing of credential evaluators is linked on the online international application.) No financial aid is available for international students at the undergraduate level. All undergraduate international applicants must certify that they have sufficient funds to pay for their education at Virginia Tech prior to being issued an I-20 or IAP-66.

All international students holding F-1 and J-1 visas must purchase health and accident insurance.

The **Cranwell International Center** provides a full range of services to international students at Virginia Tech. Such services include an orientation program especially designed to meet the needs of new international students, as well as immigration counseling and counseling for personal and financial problems. The center also coordinates a variety of cross-cultural programs designed to facilitate interaction between American and international students.

Admission (Non-Degree-Seeking Students)

Virginia Tech makes every effort to provide educational opportunities to individuals who are not seeking a degree from the university, but who wish to continue their education by taking courses at Virginia Tech for college credit or, in some cases, degree credit. Such students include, but are not limited to, students enrolled in other colleges or universities and senior citizens. Non-degree applicants must be in good standing from all previously attended educational institutions with no serious disciplinary infractions. Students will not be competitive for admission if their most recent work is below a 2.0 or their cumulative GPA is below a 2.0.

Students who enroll at Virginia Tech under this program may not be considered candidates for degrees unless they apply formally for regular undergraduate or graduate admission. At that time, minimum requirements must be met and the applicant's academic and disciplinary record at Virginia Tech and all other colleges and universities attended would be reviewed within the context of the current competition for regular admission.

Applying as a Non-Degree-Seeking Student

When applying as a non-degree-seeking student, the applicant must send the following materials to the admissions office:

- Official online application for admission as a non-degree-seeking student, plus a $60 application fee (non-refundable).
- A letter explaining the purpose of attending Virginia Tech as a non-degree-seeking student. In some cases, the Admissions Committee may request an interview.
- Unofficial transcripts from all colleges and/or universities attended.

Non-degree seeking students may apply online at **https://vt.edu/admissions**. The application should be submitted by the published deadline for the term selected (April 15 for Summer Session I, June 1 for Summer Session II, August 1 for Fall). If accepted, the applicant will receive an official notice of admission via e-mail along with other related forms.

Restrictions on Non-Degree-Seeking Students

- Students who have been denied admission to Virginia Tech as freshmen or transfer students for the same term will not be eligible for reconsideration as non-degree-seeking students.
- Non-degree-seeking students will be able to register on a space-available basis only. Until the deadline for adding classes, such students may be required to drop a class if the number of degree-seeking students exceeds the number of available spaces in a particular class.
- Non-degree-seeking students will be permitted to attempt up to 30 hours at Virginia Tech, not to exceed 11 hours in any one term during the academic year or 5 hours in either summer school term.
- Non-degree-seeking students are required to maintain an overall GPA of at least 2.0 for continued enrollment.
- Non-degree-seeking students are not eligible for financial aid, scholarships or on-campus housing.
- Students who have previously been enrolled at Virginia Tech may not reapply as non-degree-seeking students. Former students who left the university in good standing may register for classes through Hokie SPA (http://www.hokiespa.vt.edu).

Admission (Transfer Process)

Admission is offered on a competitive basis to transfer applicants with the strongest academic records and with completed courses needed in their intended major.

Competitive applicants will achieve mostly Bs or better. In majors where applications exceed available space, the competitive grades will be considerably higher. Architecture and industrial design are not available for transfer applicants. The most important factors considered for admission are: completion or substantial progress toward completing prerequisite courses -- particularly freshman English, math and science appropriate for the intended major; and overall GPA in college course work.

Applicants from accredited colleges and universities, including applicants from Virginia community colleges

who have completed two full academic years and have received an associate's degree in the University Parallel College/Transfer Program, must (1) have completed all entrance requirements, or their equivalents, in their college developmental program; (2) have a minimum GPA of 2.5 on a 4.0 scale in all previous college work attempted; and (3) be in good standing with all colleges or universities attended. The applicant's overall grade point average and the quality of the student's former academic program are critical factors in admissions considerations. Most transfer applicants who are offered admission have a minimum GPA of 3.0 (on a 4.0 scale). Prospective applicants from the Virginia Community College System will find information about guaranteed admissions agreements at **https://vt.edu/admissions/transfer/vccs.html**.

Transfer applicants must send the following application materials to the Office of Undergraduate Admissions:

- Official online application and application fee (non-refundable): $60 for freshmen, transfer, and non-degree students; $70 for international students.

  Please note: *we expect students to apply online at **https://vt.edu/admissions**.*

- Applicants are required to submit self-reported grades and test scores through the online application process.
- A final official transcript is requested after admission is offered and the student accepts the offer.
- Discharge certificate (DD214) if the applicant is a veteran.
- Domicile supporting documents if the student is requesting in-state status.

Completed applications are considered and decisions are made by the Admissions Committee. If offered admission, the applicant will receive an official notice of admission and related forms.

Transfer applications for summer/fall admission are due January 15, and will receive notification of the admissions decision by March 5. Students offered admission must respond to the offer by June 1. If space is available, transfer applications for spring admission are due October 1, decisions are mailed by November 15, and responses are due December 15.

Advanced Placement

Through Advanced Placement examinations administered in May of each year by the College Entrance Examination Board, students receiving required scores may be considered for Advanced Placement credit in certain subjects in which they show proficiency. Final determination of credit will be made after the test results have been evaluated by the university. Students must have scores sent directly to the Office of the University Registrar at Virginia Tech (school code 5859) from the College Entrance Examination Board. If scores were not directed to the University Registrar at the time of the examination, contact the College Board at (888) 308-0013.

Credits allowed for advanced placement are shown as transfer hours on Hokie SPA, and may not exceed 38 credit hours. Refer to the Office of the University Registrar's website at **https://registrar.vt.edu/Advanced-Standing-Transferable-Credit.html** for information and to view the AP Credit Table. Questions about Advanced Placement credit should be directed to the Office of the University Registrar at **transfercredit@vt.edu**.

Advanced Standing

Conditional Advanced Standing refers to an arrangement that permits a student, based on SAT or ACT scores, to place in a course without completing the prerequisite. This process also awards credit for the prerequisite after successful completion of the course. Virginia Tech offers Conditional Advanced Standing for specific English and Math courses based upon the fulfillment of the corresponding requirements. In order to be eligible for advanced standing a student must present SAT or ACT scores. Placement will display on the demographic information page of Hokie Spa prior to orientation.

Advanced standing without credit will be allowed for satisfactory completion of one to five years of study in a foreign language in a secondary school.

Advanced standing with credit will be awarded for students who qualify and meet the criteria as established by university policy. The criteria for the validating courses is it must be the first attempt and a grade of "C-" or better must be earned at Virginia Tech, or a "C" or better in transfer credit. Credit will be awarded automatically at the completion of each semester.

Applying to Graduate School

Students interested in working toward an advanced degree at Virginia Tech should contact the Graduate School for an application (**http://www.graduateschool.vt.edu**).

Undergraduate students enrolling in Graduate Programs or courses

Virginia Tech offers the opportunity to outstanding undergraduate students (Seniors/Juniors) nearing the end of their bachelor's degree program to enroll and receive credit for coursework taken to apply toward a future graduate program. Seniors with a GPA of 3.0 or better may apply to be admitted to the Dual Student Status for their last semester to take graduate-level courses. Juniors with a GPA of 3.3 or better may apply for admission in the Accelerated Undergraduate/Graduate Degree Program to take graduate courses during the senior year. Please check with your department to check for specific admissions requirements. Information about these programs is available on the Graduate School website (**http://www.graduateschool.vt.edu**)

Taking graduate-level courses

Undergraduate students wishing to enroll in graduate-level courses may do so. You should review any restrictions listed for the course in the Timetable of classes and speak with the faculty member teaching the course to obtain permission. Please note that enrollment in a graduate-level course will not allow you to receive graduate credit for the course if you become a master's or doctoral degree-seeking student without first being admitted to either the Dual or Accelerated Undergraduate/Graduate Degree Program.

Applying to Summer Sessions

Virginia Tech offers two summer sessions of approximately six weeks each. Credit courses on other than the regular time schedule, including intensive courses for teachers, are also offered. The summer sessions program features a comprehensive offering of courses and special programs, including online courses, study abroad programs, and a few undergraduate courses in Northern Virginia.

Enrolled Virginia Tech students, as well as visiting students, are invited to participate in summer sessions. Enrolled students follow the same registration procedure for summer courses as they would for fall and spring. New or visiting students may enroll in summer sessions in either a degree or non-degree status. Such students should visit **www.summer.vt.edu** for information. Entering freshmen and transfer students should contact the Office of Undergraduate Admissions to be cleared for summer entry. Freshman applicants wishing to change term of entry to summer should e-mail **appchange@vt.edu**. Entering graduate students should contact the **Graduate School**.

On-campus housing is available in the summer. For more information, contact 540-231-6207 or **housing@vt.edu**, or go to **www.housing.vt.edu**.

Summer students have access to most university academic, athletic, and recreational facilities and programs, including the Horticulture Gardens and miles of cycling and walking trails. In addition, the **Summer Arts Festival** provides free movies, concerts, and exhibits.

Additional information is available at **www.summer.vt.edu**

Entrance Tests

Freshman applicants are required to take the SAT or ACT. (Students who opt to take only the ACT also should take the ACT writing test.) The SAT or ACT should be taken by the December test date of the senior

year in high school or earlier, as scores are considered in the admissions application process. The tests are given at centers in Virginia, in all other states, and in many foreign countries. Students will self report their test scores in the online application. Once offered admissions and the applicant accepts the offer, an official test score must be sent directly to the admissions office by the testing agency or high school. Virginia Tech's CEEB number for reporting test scores is 5859. The ACT code is 4420.

Students who are homeschooled or graduating from a non-accredited high school are encouraged to also present either two SAT Subject Area test scores in math and a second area of study to be chosen by the applicant OR grades in two community college courses including one math course.

International applicants whose native language is not English, and American applicants who are English-speaking but whose native language is not English also are required to take the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) test.

Equal Opportunity / Affirmitative Action Statement

Virginia Tech does not discriminate against employees, students, or applicants on the basis of age, color, disability, gender, national origin, political affiliation, race, religion, sexual orientation or veteran status. Discrimination or harassment on any of these bases is prohibited by **Policy 1025**, "Anti-Discrimination and Harassment Prevention Policy."

The university is subject to Titles VI and VII of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Sections 503 and 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990, the Age Discrimination in Employment Act, the Vietnam Era Veterans' Readjustment Assistant Act of 1974, the Federal Executive Order 11246, Virginia's State Executive Order Number Two, and all other rules and regulations that are applicable.

Those having questions or concerns about Policy 1025, any of these regulations, or related issues should contact:

Virginia Tech Human Resources
Office for Equity and Access
South Gate Center, Ste. 179 (0319)
Blacksburg, VA 24061.
(540) 231-9331

International Baccalaureate

Virginia Tech recognizes the International Baccalaureate (IB) diploma or certificate by awarding credit in accordance with institutional policies. The university encourages completion of the IB diploma. Students must have transcripts sent directly to the Office of the University Registrar at Virginia Tech from the IB Board. If scores were not directed to the University Registrar upon completion of the diploma or certificate, refer to the IB website at **http://www.ibo.org** for information on how to have the results sent.

Score requirements to receive credit may be viewed at **https://registrar.vt.edu/Advanced-Standing-Transferable-Credit.html**

With the IB Diploma, credit is awarded for Higher Level (HL) courses based on minimum scores shown in the HL Credit Table. Credit for only one Standard Level (SL) course is awarded provided the minimum score shown in the SL Credit Table is earned. A maximum of 38 hours may be awarded.

With the IB Certificate, credit is awarded for Higher Level (HL) courses based on minimum scores shown in the HL Credit Table. No credit is awarded for Standard Level (SL) courses. In addition, no credit is awarded for Theory of Knowledge or Extended Essay. A maximum of 30 hours may be awarded.

Questions about IB credit should be directed to the Office of the University Registrar at **transfercredit@vt.edu**.

New Student Programs

New Student Programs creates transitional opportunities to prepare new students for academic and co-curricular experiences at Virginia Tech through cultivating an environment that embraces learning, diversity, inclusion, and welcoming of all new Hokies.

Orientation

Orientation is the first stepping-stone in the transition to Virginia Tech. During orientation, entering students will have the opportunity to interact with the student orientation team and other new students, learn about campus resources, as well as meet with college or department representatives and register for fall semester courses. Orientation is designed to give incoming Hokies and their guests the information they need to feel confident and comfortable about a collegiate career at Virginia Tech.

First-year students and their parent(s)/families members have the opportunity to attend a two-day orientation session each summer. Transfer students and their parent(s)/family members attend a one-day orientation session in June.

Spring Orientation: Students who will enter Virginia Tech in the spring semester are invited to attend the Spring Orientation program in January before the beginning of spring classes.

Information is available at **https://nsp.vt.edu/orientation.html**

Welcome Week

Welcome Week is a series of events and Hokie traditions designed to welcome all students back to campus. Students will kick off the school year by connecting with campus and the Hokie community through a variety of social, cultural, and educational activities. Events include the Hokie Hi Picnic in Lane Stadium, a movie on the Drillfield, Gobblerfest, and much more. Information is available at **https://nsp.vt.edu/welcome.html**

New Student Programs | 540-231-3284 | www.nsp.vt.edu | orientation@vt.edu

Requirements (Computer)

Students are required to have their own personal computer. The university annually establishes baseline specifications for each new entering class. Transfer students are subject to the requirement that was in place for students at the same class level into which they enter. Broad specifications are announced by mid-May for students entering in the fall of the next academic year. Some departments and colleges recommend a specific configuration from among the options outlined by the university. Virginia Tech requires that entering students have a laptop or tablet computer and strongly recommends that entering students obtain a computer that meets (or exceeds) the university general specifications. If you have declared a major, check the college and department specifications. Complete information about the computer requirement can be found online at **www.compreq.vt.edu**.

Requirements (Minimum Freshman Entrance)

A student must complete a minimum of 18 units before enrolling at Virginia Tech. One unit is equal to one academic year of study in a selected course. Students who will graduate from a program other than an accredited high school program should check the 'What do we need from you" section at **https://vt.edu/admissions/undergraduate/apply/checklist.html**, and contact the Office of Undergraduate Admissions for additional information.

At least 14 of the 18 units must be academic or college preparatory units. Academic or college preparatory units are courses in English, language studies, mathematics, natural sciences, social sciences, and fine arts. They must be distributed as indicated below. Admission to Virginia Tech is competitive, those offered admission have A/B averages.

Of the 18 required units, the following minimums must be met:

- **English** - 4 units, one in each year of high school.
- **Math** - 3 units, including algebra I, algebra II and geometry. Admission preference will be given to those who complete math beyond algebra II. A fourth unit of math is required for engineering, building construction, chemistry, computer science, mathematics, physics, and statistics majors. A fourth unit of math is strongly recommended for Pamplin College of Business majors. The fourth unit of math must include one-half unit of trigonometry and one-half unit of advanced algebra or higher mathematics. A fifth unit of math (e.g., calculus) is preferred for engineering majors.
- **Social Science** - 2 units; 1 unit must be in history.
- **Laboratory Science** - 2 units; units must be chosen from biology, chemistry, or physics. 3 units (including chemistry and physics) are recommended for engineering and for all science-related majors.
- **Additional Academic Units** - 3 units from college preparatory courses. These may be electively chosen from English, natural sciences, social sciences, history, mathematics, computer science, language studies, and fine arts. These courses must be comparable in content and purpose to other required academic or college preparatory courses.
- The remaining 4 units may be selected from any course offerings for which the high school grants credit toward graduation.

By the time they graduate from the university, students must meet a language study requirement. The minimum requirement may be met in high school by completing 2 units of a single foreign or classical language. Some majors in the College of Liberal Arts and Human Sciences and the College of Science may require 3 units. The requirement also may be met after admission by one of the following:

- Earning 6 semester hours of college-level foreign or classical language credit.
- Receiving credit by examination for a foreign or classical language.

Virginia Tech reserves the right to deny admission to students who have been dismissed or suspended for academic or disciplinary reasons or to those convicted of a felony or a serious misdemeanor impacting the safety of the university community.

Student Health History

Each student entering Virginia Tech must furnish a health history form, completed by a home physician, for the University Student Health Services. The form will be available online to applicants who accept the offer of admission. Failure to meet Health Services standards may result in dismissal from the university. Information is available at **http://www.healthcenter.vt.edu.**

Transfer Student Credentials Evaluation

For new incoming students, official final academic transcripts from all colleges previously attended should be submitted to the Office of Undergraduate Admissions. Courses from another institution in which a grade of "C-" or lower was earned, and courses taken on a pass/fail or audit basis, are not acceptable for transfer credit. Only grades of "C" or higher in courses consistent with those offered at Virginia Tech are certified for transfer credit. Grades in transfer courses do not transfer or appear on a student's record at Virginia Tech, and are not included in a student's Virginia Tech GPA computation. Credit will be awarded based on Virginia Tech policies

AP, IB, Cambridge, and CLEP scores should be sent directly to the University Registrar at Virginia Tech from the testing services. Credit will not be awarded from high school transcripts or another institution's transcripts. Refer to the Office of the University Registrar's website at **https://registrar.vt.edu/Advanced-Standing-Transferable-Credit.html** for contact information for testing services and to view the AP, IB, Cambridge, and CLEP Credit Tables.

No more than 50 percent of the credits required for graduation from Virginia Tech may be transferred from two-year colleges. To receive transfer credit, official academic transcripts from all colleges previously attended

should be received in the Office of the University Registrar no later than the end of the first term of the student's first enrollment at Virginia Tech. Class standing will be based upon the number of credits designated as acceptable for meeting graduation requirements. All transfer credits are used in the computation of academic eligibility.

International transfer students are required to submit additional documentation. For a list of required documentation for Admissions see **https://vt.edu/admissions/undergraduate/apply/checklists.html**. The Office of the University Registrar requires documentation in addition to what is needed for Undergraduate Admissions, in order to evaluate. For the required information please see **http://www.tranguide.registrar.vt.edu/2017/requirements.html#internationalrequirements**.

Transfer Policy of Virginia Community College Students

Admission preference shall be given to transfer students who have completed an A.A., A.S., or A.A.S. (Associate in Arts and Sciences) at the Virginia Community College System or Richard Bland College. While some courses from the Associate of Applied Science degree from a Virginia Community College or Richard Bland College may transfer to Virginia Tech, the Associate of Applied Science degree does not transfer.

Per *State Policy on Transfer*, students who receive their associate degrees from transfer programs at a Virginia Community College or Richard Bland College, based upon a baccalaureate-oriented sequence of courses appropriate for their major, and are offered admission to Virginia Tech will be granted junior level status upon admission. Additionally, these students will have fulfilled the requirements of the Curriculum for Liberal Education (CLE) or Pathways to General Education, except for departments with specific general education requirements. However, it may take such students longer than two years to complete the baccalaureate degree at Virginia Tech because of major prerequisites and other circumstances or requirements. Transfer students shall have the same opportunities as other students in areas of residence and dining programs, registration, and scholarships and financial aid.

Admission preference shall be given to transfer students who have completed an A.A., A.S., or A.A.S. (Associate in Arts and Sciences) at the Virginia Community College System or Richard Bland College. While some courses from the Associate of Applied Science degree from a Virginia Community College or Richard Bland College may transfer to Virginia Tech, the Associate of Applied Science degree does not transfer. Transfer students shall have the same opportunities as other students in areas of residence and dining programs, registration, and scholarships and financial aid.

Complete **Virginia Tech Transfer Guide**

University of Cambridge International Examinations

Cambridge International exams, commonly known as A levels or AS levels, are administered by the University of Cambridge. Virginia Tech recognizes and awards credit for University of Cambridge International Exams based upon the receipt of an official transcript. Students must request an official transcript directly from Cambridge International Examinations or other designated testing agency (Edexcel, etc.) and have this sent to the Office of the University Registrar. Credit will not be considered based on a high school transcript. Credit can be viewed on Hokie SPA under the grades menu. A maximum of 38 credit hours may be awarded.

Refer to the Office of the University Registrar's website at **http://registrar.vt.edu/registration-multi-brief/ap-ib-clep-credit.html** for information and to view the Cambridge Credit Table. Questions about Cambridge credit should be directed to the Office of the University Registrar at **transfercredit@vt.edu**.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Using this Catalog

Abbreviations

Miscellaneous abbreviations used only in the course descriptions include:

C-	credits	I-	Fall semester
Co-	corequisite	II-	Spring semester
H-	hours in classroom	III-	First summer session
L-	hours in laboratory	IV-	Second summer session
Pre-	prerequisite		

The Roman numeral designations for the terms in which courses are offered are intended only as general guides and do not indicate binding agreement to offer in those terms.

Course Descriptions

ALCE - Agricultural, Leadership, and Community Education
ALS - Agriculture and Life Sciences
AOE - Aerospace and Ocean Engineering
APS - Appalachian Studies
APSC - Animal and Poultry Sciences
ARBC - Arabic
ARCH - Architecture
ART - Art and Art History
AS - Aerospace Studies (AFROTC)
AT - Agricultural Technology
BDS - Behavioral Decision Science
BC - Building Construction
BCHM - Biochemistry
BIOL - Biological Sciences
BIT - Business Information Technology
BMES - Biomedical Engineering and Sciences
BMSP - Biomedical Sciences and Pathobiology
BMVS - Biomedical & Veterinary Sciences
BSE - Biological Systems Engineering
BUS - Business
CAUS - College of Architecture and Urban Studies
CEE - Civil and Environmental Engineering
CEM - Construction Engineering and Management
CHE - Chemical Engineering
CHEM - Chemistry
CHN - Chinese
CINE - Cinema
CLA - Classics
CMDA - Computational Modeling and Data Analytics
CMST - Communication Studies
COMM - Communication
CONS - Consumer Studies
COS - College of Science
CRIM - Criminology
CS - Computer Science
CSES - Crop and Soil Environmental Sciences
DANC - Dance
DASC - Dairy Science
ECE - Electrical and Computer Engineering
ECON - Economics
EDCI - Curriculum and Instruction
EDCO - Counselor Education
EDCT - Career and Technical Education
EDEP - Educational Psychology
EDIT - Instructional Design & Tech
EDTE - Technology Education
ENGE - Engineering Education
ENGL - English
ENGR - Engineering
ENSC - Environmental Science
ENT - Entomology

ESM - Engineering Science and Mechanics
FA - Fine Arts
FCS - Family and Consumer Sciences
FIN - Finance, Insurance, Business Law
FIW - Fisheries and Wildlife Sciences
FL - Foreign Language
FMD - Fashion Merchandising
FR - French
FREC - Forest Resources and Environmental Conservation
FST - Food Science and Technology
GEOG - Geography
GEOS - Geosciences
GER - German
GR - Greek
HD - Human Development
HEB - Hebrew
HIST - History
HNFE - Human Nutrition, Foods and Exercise
HORT - Horticulture
HTM - Hospitality and Tourism Management
HUM - Humanities
IDS - Industrial Design
IS - International Studies
ISC - Integrated Science
ISE - Industrial and Systems Engineering
ITAL - Italian
ITDS - Interior Design
JMC - Journalism and Mass Communication
JPN - Japanese
JUD - Judaic Studies
KOR - Korean
LAHS - Liberal Arts and Human Sciences
LAR - Landscape Architecture
LAT - Latin
LDRS - Leadership Studies
MASC - Mathematical Sciences
MATH - Mathematics
ME - Mechanical Engineering
MGT - Management
MINE - Mining and Minerals Engineering
MKTG - Marketing
MN - Military Navy (NROTC)
MS - Military Science (AROTC)
MSE - Materials Science and Engineering
MTRG - Meteorology
MUS - Music
NANO - Nanoscience
NEUR - Neuroscience
NR - Natural Resources
NSEG - Nuclear Science Engineering
PHIL - Philosophy

PHS - Population Health Sciences
PHYS - Physics
PM - Property Management
PORT - Portuguese
PPWS - Plant Pathology, Physiology, and Weed Science
PR - Public Relations
PSCI - Political Science
PSVP - Peace Studies
PSYC - Psychology
REAL - Real Estate
RED - Residential Environments and Design
RLCL - Religion and Culture
RUS - Russian
SBIO - Sustainable Biomaterials
SOC - Sociology
SPAN - Spanish
SPIA - School of Public and International Affairs
STAT - Statistics
STL - Science, Technology, and Law
STS - Science Technology Studies
SYSB - Systems Biology
TA - Theatre Arts
TBMH - Translational Biology, Medicine, and Health
UAP - Urban Affairs and Planning
UH - University Honors
UNIV - University Course Series
VM - Veterinary Medicine
WATR - Water
WGS - Women's and Gender Studies

Changes in Catalog Information

Caution: The course offerings and requirements of Virginia Tech are under examination and revision continually. This catalog presents the offerings and requirements in effect at time of publication, but in no way guarantees that they will not be changed or revoked. The regulations and policies may change to meet new needs or as legislation is approved. Such changes are published in the President's Policy Memoranda. Courses not taught for five years shall be removed from the Undergraduate Catalog.

The policies and regulations that appear in this catalog are not meant to form a contract or to constitute an offer of one. Current information may be obtained from the following:

- *Undergraduate Admission Requirements:* **Director of Admissions.**
- *Course Offerings:* **Academic departments offering the course(s) in question.**
- *Degree Requirements:* **Office of the University Registrar, head of major department, or academic dean of the college.**
- *Fees and Tuition:* **Office of the University Bursar.**

Course Numbering System

The first digit in course number designations denotes the year in which the course ordinarily is found in the curricular outlines or "checksheets," which are available from the major department or academic advisor. The second and third digits make the course number unique within a department. The fourth digit is 4 if the course is a one-term terminal course, 5 if the course is the first term in a sequence, and 6 if the second term in a

sequence. As a general rule, courses with 0 as the first digit do not carry university credit. Agricultural Technology courses, however, are an exception.

Undergraduate (UG)	1000 - 4000
Graduate (GR)	4000 - 6000
Professional (PR)	9000
Medical (MD)	9000

Cross Listed Courses

Courses that are cross listed between departments may not be counted twice toward meeting graduation requirements. No credit will be allowed for a course taken that duplicates subject matter in a course for which credit already has been received. Cross listed courses are indicated in the title line of course descriptions; for instance, REL 3454 is listed as follows:

- 3454 (PHIL 3454): PHILOSOPHY OF RELIGION

The first number is the Religion course number, while the number in parentheses indicates that the course is cross listed with Philosophy.

Graduate Course Listings

Information regarding graduate courses (5000 and above) may be found in the **Graduate Catalog**.

Prerequisite Notations and Requirements

Students are permitted to take courses without having the specified prerequisites only upon obtaining the consent of the instructor. Students who enroll in a course for which they have not clearly satisfied the prerequisites or equivalent, or obtained the appropriate permission, may be dropped from the course. Deliberately false statements testifying to the satisfaction of prerequisites constitute a violation of the honor code. Students have the right to appeal a decision about prerequisites to the head of the department offering a course. Students should recognize that 3000 and 4000 level courses assume a certain level of academic maturity and general background regardless of the stated prerequisites. The course instructor can be consulted regarding the implications of this expectation for a specific course. Students must consult with the instructor if they wish to use the Pass/Fail option in a course for which they do not have the prerequisites.

Students should note prerequisite and corequisite requirements as stated in the course descriptions. Courses in a series may be taken independently where the series of course numbers is separated by commas (e.g., 3135, 3136), in the catalog listing. Where the series of course numbers is connected by hyphens (e.g., 4135-4136), the first course is prerequisite for the next one.

Tables

The numbers on the right hand side of tables listed under certain departments denote the number of hours the class meets each week during the term and, in parentheses, the number of credits allowed for the course. A listing such as 3(3) means that the course meets three hours each week and three credits are earned.

University Course Series (UNIV)

University Course Series are courses sponsored to enhance the undergraduate academic experience. The courses may not count toward degree credit. Check with your advisor or academic dean to verify degree applicability.

Undergraduate Course Descriptions (UNIV)

1004: COLLEGE SUCCESS STRATEGIES
Study and application of strategies, skills, attitudes and behaviors leading to effective academic learning in a college setting. Credit not applicable to meeting degree requirements; may not be repeated. (3H,3C)

1704: FIRST YEAR SEMINAR COURSE
Introductory exploration of academic and social competencies contexts and responsible decision-making within a residential learning community environment. Pre: Consent required. May not count towards degree requirements; consult advisor. (3H,3C)

1824: PATHWAYS TO SUCCESS: EXPLORING YOUR FUTURE
Introductory experience course for University Studies and Explore Technology majors. Create fundamental knowledge and develop skills that facilitate successful transition to the university and develop decision-making skills, problem solving, inquiry, research majors and careers, critical thinking and integration of knowledge. Examine personal decision towards their major utilizing psychosocial and identity in support of a successful transition. Evaluate sources of information to make an argument. (3H,3C)

1984: SPECIAL STUDY
May not count towards degree requirements; consult advisor. Variable credit course.

2004: EXPLORING CAREERS: MAKING DECISIONS AND PLANS
Integrates the role of careers in society, career development theories, decision making models and styles and self-assessment interpretation. Analyzes career and major research, introduces job search strategies and defines professional behavior required in the workplace. Facilitates effective decisions in the choice of academic majors and career options. Pass/Fail only. (3H,3C)

2394: INTRODUCTION TO RESIDENTIAL COMMUNITIES AND LEADERSHIP
This course provides theories, basic principles, and skill development that serve as a knowledge base and framework for the peer helping, para-professional Resident Advisor position. This course is open only to students who are serving in their first semester as a Resident Advisor. (3H,3C)

2984: SPECIAL STUDY
May not count towards degree requirements; consult advisor. Variable credit course.

3954: STUDY ABROAD
May not count towards degree requirements; consult advisor. Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
May not count towards degree requirements; consult advisor. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Financial Information

Auditing

Students are assessed the same rate for tuition and fees for auditing courses as for courses taken for credit.

Billing Statements (E-Bill)

Student Accounts are billed electronically. Current e-bills, e-bill history, and real-time current account activity are viewed in the e-billing system accessed through the student portal (Hokie SPA). E-bills are prepared at least monthly for new charges. Payment is required by due date on the statement to avoid penalties such as a late fee, registration hold, and cancellation of registration.

The initial e-bill for fall semester is posted mid-July and is due August 10. Updated e-bills are produced mid-

August and again following the last day to add. Financial arrangements and payments must be in place to cover all charges no later than one week following the last day to add classes each semester to avoid cancellation of enrollment for the term. The initial e-bill for spring semester is posted in mid-December and is due January 10. After, a schedule similar to the fall e-bill schedule is followed. E-bills for the summer and winter terms will be posted at least one month prior to the start of each term.

Past due charges incur a late fee and will prevent access to drop/add and prevent pre-registration for the upcoming semester. In addition, past due charges from a prior semester incur finance charges.

Budget Tuition Plan

Virginia Tech's Budget Tuition Plan (BTP) offers a convenient method for planning and budgeting payment of tuition, fees, room, and board each semester. The BTP can cover all or part of the institutional charges. This plan provides the opportunity for the student or authorized family member to enroll in scheduled payments. The only cost for this service is a non-refundable application fee due with the application each semester. Students can join the BTP online through Hokie SPA. Please see **wallet.vt.edu** for additional information.

Bursar

The Office of the University Bursar is responsible for the billing of tuition, fees, housing, dining plans and many other student and related charges. Billing statements are electronically generated monthly for new account activity and any previous balance. The e-bill can be viewed on the student portal Hokie SPA and payment can be made by e-check or by credit card. Payment can also be made by mail or in person at the Bursar Office in 150 Student Services Building.

Students may authorize parents or others as payers on their e-bill account. Unless revoked by the student, the authorized payer receives the e-bill notification monthly and is able to view the account and make payments electronically to the student's account.

Release of Financial Information to a third party such as parent(s) and/or guardian(s) requires student authorization under the Family Educational Rights and Privacy Act (FERPA). The FERPA disclosure can be done via the Hokie SPA.

Detailed information regarding tuition and fees, payment deadlines, customer service window hours, the Budget Tuition Plan, electronic billing and payment processes, and much more are available on the Bursar's website **www.bursar.vt.edu**.

Collection of Past Due Receivables for Students

Any amount owed to the university including, but not limited to, tuition, fees, room, board, loans, notes receivable, and amounts due for goods and services provided is considered a receivable to the university. A receivable becomes past due if payment is not received by the payment due date. At ninety days past due, the receivable becomes delinquent.

For currently enrolled students, the primary collection tool is the placement of a "HOLD" by the Office of the University Bursar on a student's record. This "HOLD" restricts certain student activities such as the ability to add or drop classes, receive official transcripts and diplomas, and registration for future academic terms. Once established, the "HOLD" remains in place until the debt is paid in full. When a student is no longer enrolled, the collection procedures utilized for other "non-student" receivables are implemented.

Individuals are responsible to pay all fees and charges owed to Virginia Tech. If the individual defaults on payment, has a returned check, e-check, or debit of said fees and charges, or has any delinquent amount owed, the individual must pay a penalty fee, interest at the highest rate allowed by law or as agreed to with Virginia Tech, and all reasonable administrative costs, collections fees, and attorney's fees incurred in the collection of amounts due the university. Students will be notified by an email sent to their Virginia Tech email address to alert them that a statement has been generated. Virginia Tech and their respective agents or

contractors may contact individuals regarding any amounts owed, at the current or any future number provided for the cellular phone or other wireless device using automated telephone dialing equipment or artificial or pre-recorded voice or text messages.

Addresses must be kept current and can be changed by students as needed on Hokie SPA. Non-receipt of e-bill notification is not a valid defense for non-payment; it is the responsibility of the individual who has incurred the debt to see that the debt is discharged.

For non-students, a dunning message is included on each month's statement alerting the customer to the next collection steps that will be taken. If payment is not forthcoming within the stated period, the account and all pertinent information are forwarded to an outside collection agency for further collection efforts. In addition, the account is reported to national credit bureaus, thus affecting the debtor's credit rating.

In addition to the above measures, the university also lists the account with the Virginia Department of Taxation for set-off debt collection procedures. This means that any state income tax refund or payment processed through the State Treasurer's Office to the debtor will be reduced by the amount of the receivable owed by the debtor.

Office of the University Bursar (0143)
Student Services Building, Suite 150, Virginia Tech
800 Washington Street SW
Blacksburg, VA 24061
540/231-6277
Fax: 540/231-3238
E-mail: **bursar@vt.edu**
Web: **http://www.bursar.vt.edu**

Eligibility for In-State Tuition

Eligibility for in-state tuition privileges and reduced rate tuition eligibility is governed by §§23.1-500 through 23.1-510 of the Code of Virginia. The provisions of §23.1-500 of the Code of Virginia are set forth, defined, and discussed in the State Council of Higher Education for Virginia's Domicile Guidelines **http://www.schev.edu/index/tuition-aid/in-state-residency/financial-aid-policy-and-procedures**. SCHEV developed these Guidelines to facilitate the consideration of uniform criteria in determining domiciliary status. §§23.1-500 through of the Code of Virginia places the responsibility on the student for establishing by clear and convincing evidence that s/he is eligible for the in-state tuition rate. Further, the burden is on the applicant to demonstrate by clear and convincing evidence that his/her domicile is Virginia and that s/he has abandoned any prior domicile. According to SCHEV's Guidelines, clear and convincing evidence is defined as "that degree of proof that will produce a firm conviction or a firm belief as to the facts sought to be established. The evidence must justify the claim both clearly and convincingly." Please visit SCHEV's website at **http://www.schev.edu/index/tuition-aid/in-state-residency** for additional information.

Residence or physical presence in Virginia primarily to attend the university does not entitle students to in-state tuition rates. Domicile for tuition purposes should be established before one enters the University. Please note that if a student enters the University classified as an out-of-state student, the student must present clear and convincing evidence to rebut the presumption that they are residing in the state primarily to attend school. Students seeking reclassification to in-state status must be prepared to pay the out-of-state tuition rate unless they are notified in writing that their status has been reclassified to in-state tuition.

Domicile classification is determined at the time of a student's admission to Virginia Tech. Undergraduate transfer and freshman applicants for admission apply for in-state status at the time they apply to Virginia Tech. For additional information please contact:

Office of Undergraduate Admissions
925 Prices Fork Road, Mail Code 0202
Blacksburg, VA 24061
https://vt.edu/admissions/undergraduate.html
(540) 231-6267

domicile@vt.edu

Continuing or returning undergraduate students classified as out of state who believe they qualify for in-state tuition may apply for changes in residency status through the Office of the University Registrar by completing the Application for Virginia in-state tuition rates. Applications must be received prior to the first day of class for the semester that in-state tuition privileges are sought. Please email **residency@vt.edu** for additional information. For additional information please contact:

Office of the University Registrar
Suite 250 Student Services Building
800 Washington Street, SW, Mail Code 0134
Blacksburg, VA 24061
www.registrar.vt.edu
(540) 231-6252
residency@vt.edu

The regulations governing domicile are determined by state law, and are therefore subject to change. The information stated herein is not intended to be a contract between a student and Virginia Tech but is provided for informational purposes only.

Eligibility for in-state tuition rates through the Veterans' Choice Act of 2014

A Veteran using educational assistance under either chapter 30 (Montgomery G.I. Bill - Active Duty Program) or chapter 33 (Post-9/11 G.I. Bill), of title 38, United States Code, who lives in Virginia while attending a school located in Virginia (regardless of his/her formal State of residence) and enrolls in the school within three years of discharge or release from a period of active duty service of 90 days or more.

Anyone using transferred Post-9/11 GI Bill benefits (38 U.S.C. § 3319) who lives in Virginia while attending a school located in Virginia (regardless of his/her formal State of residence) and enrolls in the school within three years of the transferor's discharge or release from a period of active duty service of 90 days or more.

Anyone described above while he or she remains continuously enrolled (other than during regularly scheduled breaks between courses, semesters, or terms) at the same school. The person so described must have enrolled in the school prior to the expiration of the three year period following discharge or release as described above and must be using educational benefits under either chapter 30 or chapter 33, of title 38, United States Code.

Anyone using benefits under the Marine Gunnery Sergeant John David Fry Scholarship (38 U.S.C. § 3311(b)(9)) who lives in Virginia while attending a school located in Virginia (regardless of his/her formal State of residence).

Anyone using transferred Post-9/11 G.I. Bill benefits (38 U.S.C. § 3319) who lives in Virginia while attending a school located in Virginia (regardless of his/her formal state of residence) and the transferor is a member of the uniformed service who is serving on active duty.

Enrollment Status (Full Time)

Certification of full-time student status, for most purposes, U.S. Department of Veterans Affairs (V.A.) educational benefits, Social Security benefits, loans, scholarships, and grants, is based on the following enrollment information: official undergraduate and College of Veterinary Medicine enrollment for each regular semester must be 12 or more credit hours and official graduate enrollment for each regular semester must be 9 or more credit hours. All courses must be in the A/F option, P/F option, or equivalent credit. Please note that courses taken under the audit option do not count toward the enrollment status. Participation in the Virginia Tech Cooperative Education program, National Student Exchange program, and International Student Exchange program reflects full-time enrollment. Certification of enrollment for V.A. educational benefits will reflect only those hours considered to be progress toward the degree or educational objective. Although considered to be enrolled full-time, students who participate in the Cooperative Education program are not eligible for V.A. educational benefits or federal financial aid during the terms in which they participate in the

Co-Op program.

Fees (Cooperative Education Program)

Students are assessed a Cooperative Education Program Fee of $75 for each term a student is placed in industry employment while enrolled in the Cooperative Education Program. Details available on the Bursar's website **http://www.bursar.vt.edu**.

Fees (Late Payment)

The late fee charge is 10% of unpaid balance up to a maximum of $125 per term if payment is not received by the due date on the billing statement.

Students receiving Veterans Education benefits

Once Virginia Tech receives a valid VA authorization, such as a VAF 28-1905 for Chapter 31 VR&E beneficiaries, Certificate of Eligibility (COE) or "Statement of Benefits" for Chapter 33 Post 9/11 GI Bill recipients, and the student has submitted a request to use such entitlement, the covered student will be permitted to participate in the approved course(s) while awaiting payment from the VA for a period of 90 days from the date Virginia Tech submits a valid invoice for tuition/fees (T&F) to VA. For attendance costs a student's Veterans Affairs benefits will cover, Virginia Tech will not impose any penalty, including the assessment of late fees; the denial of access to classes, libraries or other institutional facilities; or require any covered individual to borrow additional funds due to delayed T&F payments from the VA.

Fees (Reinstatement)

Classes are dropped for non-payment of charges after the tenth day of classes for fall and spring semesters. A $75.00 reinstatement fee and late payment fee will be assessed to students desiring to register once class registrations are cancelled due to non-payment of fees. Students will have five business days to report to the Office of the University Bursar, 150 Student Services Building, to pay charges in full and have the hold removed from their record before the academic dean can reinstate courses. Students will be provided a memo showing payment has been made to present to the academic dean when requesting reinstatement of classes. Failure to remit payment within five business days of cancelled registration may result in denial of reinstatement request.

Fees (Tuition)

Information on Tuition and Fee costs as well as costs for room and board can be viewed on the **Bursar's website (www.bursar.vt.edu)**.

Medical Resignations

A student resigning for medical reasons will be charged a daily tuition rate for each day enrolled.

Resignations for medical reasons must be recommended by Schiffert Health Center or Cook Counseling Center at Virginia Tech indicating the student is unable to continue in school due to medical reasons. Schiffert Health Center or Cook Counseling Center will recommend an effective date for a medical resignation. Recommendations are forwarded to the student’s academic dean. It is the purview of the Academic Dean to approve the recommendation. The Academic Fee, Technology Fee, Capital Fee and Comprehensive Fees are non refundable and no reduction will be made after the first day of classes for resignations.

Military Withdrawals

Students called into active military duty are encouraged to communicate with their advisors, instructors, and

undergraduate or graduate deans to arrange "incompletes" or rescheduling of remaining work if their orders are received near the end of a term. However, if students request a withdrawal from the university, permission is granted without punitive action as well as granting a full refund of tuition and fees. This full refund is requested regardless of the date of the action of withdrawal. Procedurally, students (or their parents or guardians) are requested to provide copies of activation orders. If orders are unobtainable (in some emergency call-ups, this is possible), the University Registrar will telephone the company commander for verbal confirmation. Further, the University Registrar will serve as facilitator of this process for any advisor, instructor, or dean seeking verification of the students' military status. Students with Federal Financial Aid should be advised that full refund of tuition will result in an immediate requirement to commence repayment of aid. Students with federal financial aid are to be given the option of full or partial refund. Students are to work with their advisors and deans in requesting reinstatement to the university.

Reinstatement: All students leaving under the military withdrawal policy are entitled to reinstatement into the same program of study. Students are directed to seek advising from their advisors or academic deans. If absent more than five years, certain majors may require re-taking of specific major courses.

Defer Initial Enrollment: Students called up for active duty may defer initial enrollment (in the same major) if:

- The student returns to Virginia Tech after a cumulative absence of not more than five years, and
- The student provides notice of intent to return to Virginia Tech not later than three years after completion of the period of service.

Payment Directions

The most efficient and direct methods of payment include the electronic payment accessible in the e-bill system and the Budget Tuition Plan.

If paying by mail, please make the check payable to Treasurer of Virginia Tech. Print the PDF version of the e-bill and enclose the remittance advice with your check to ensure proper payment application. Mail to Office of the University Bursar (MC0143), Student Services Building, Suite 150, Virginia Tech, 800 Washington Street SW, Blacksburg, VA 24061. When mailing payment, please do not send cash. See wallet.vt.edu for additional payment options.

Refund Policy

Virginia Tech requires that payment of wages or salaries, travel or expense reimbursement, and student refunds be processed by direct deposit into an account in the name of the student at a financial institution in the United States designated by the student. The student can enroll in direct deposit online through Hokie SPA under the Hokie Wallet menu. Refund processing priority is given to students enrolled in direct deposit. If the student has not provided bank account information, a refund check will be mailed to the permanent address listed on Hokie SPA at the time the refund is processed. Requests for replacement refund checks must be in writing and will not be accepted until 14 calendar days after the date the original check was issued and mailed.

Refunds (Room and Board)

Students holding a residence hall contract who leave the university during the first week of class will forfeit $100 of their residence hall fee. Thereafter, the semester room charge, less than $100, will be refunded over the first six weeks of the semester. Students withdrawing after the beginning of the seventh week of the semester are charged the full room rate.

Students who purchase a declining balance dining plan will be charged a forfeiture fee of $100 during the first week for a Major, Mega, or Premium dining plan and $35 during the first week for a Minor Flex or Commuter Cash dining plan. Beginning in week two and throughout the remainder of the semester, students will forfeit the base cost and will be refunded any unused dollars in the declining balance account. Commuter Cash dining plan holders will receive a refund of the remaining dollars on the plan less a $35 forfeiture fee. Refunds

are calculated from the date the resignation is processed by the university or the last day of dining plan use, whichever is later. No refund will be granted for a resignation backdated for a previous semester.

Students with a balance in a Dining Dollars, Flex Additions, or Hokie Passport account will receive a credit on their student account of the balance less a $15 processing fee per account. Questions concerning adjustments to room charges should be directed to the Office of Housing & Residence Life at (540) 231-6205. Questions concerning adjustments to dining plan charges should be directed to Hokie Passport Services at (540) 231-5121.

Refunds (Tuition)

The refund schedules below list the student refund for withdrawals, resignations, and reduced course load for the fall and spring semesters. Schedules by calendar day as well as schedules for winter and summer are published on the bursar's website under Refund Policy. Students considering reducing their course load or resigning should always review examples of the calculation of any refund before actually dropping the course or resigning. Students receiving financial aid should contact the University Scholarships & Financial Aid Office prior to dropping the course to determine the impact on their financial aid.

Fees are defined as the comprehensive fees (full or part time) and any laboratory or resource fee associated with a particular course. When dropping a course, please note the non-refundable nature of fees after the first week of classes. Tuition and fee refunds for resignations are based on the effective date of resignation as determined by the student's associate dean. If there is a question related to the effective date of resignation, the student should contact their college.

Fall and Spring Semesters	
Tuition Refund Schedule for Reduced Course Loads	
Semester Class Day	**Student Refund**
One through five	100% of Tuition and Fees
Six through eight	90% of Tuition ONLY
Nine through nineteen	50% of Tuition ONLY
Twenty through thirty-seven	25% of Tuition ONLY
After day thirty-seven	0%
Tuition Refund Schedule for Withdrawals & Resignations	
Semester Class Day	**Student Refund**
One	100% of Tuition and Fees
Two through eight	90% of Tuition ONLY
Nine through nineteen	50% of Tuition ONLY
Twenty through thirty-seven	25% of Tuition ONLY
After day thirty-seven	0%

Fall and Spring Semesters:

- All refunds will be calculated from the official date of resignation, which may not necessarily be the last day of class attendance. No refund will be granted for retroactive/back-dated resignations.
- The technology, library, capital, comprehensive, laboratory and resource fees are non-refundable and no reduction will be made after the first day of class for resignations and after the fifth day of class for reduced course loads.

Financial Aid

Virginia Tech awards financial aid to eligible students in the form of scholarships, grants, loans, and employment. The majority of financial aid is intended for fulltime students with financial need.

To apply, entering freshmen, transfer students and returning Virginia Tech students should submit the Free Application for Federal Student Aid (FAFSA) electronically at **https://fafsa.gov**. The Office of University Scholarships and Financial Aid's priority deadline is March 1 for the upcoming academic year. The FAFSA opens on October 1 each year.

The priority deadline applies to all financial aid programs except the Federal Pell Grant, Federal Direct Subsidized and Unsubsidized, Federal Direct Grad PLUS and Federal Direct Parent PLUS Loan Programs.

Applicants for scholarships and financial aid must list Virginia Tech's institutional school code number 003754 on the FAFSA for the analysis of the FAFSA to be sent to Virginia Tech. Students must complete and submit a new FAFSA each year to be considered for financial aid at Virginia Tech.

All offers of financial aid are contingent upon receipt of anticipated federal and state funds by the university. Awards may be reduced or canceled if anticipated funds are not received. Offers of financial aid are subject to full-time enrollment and the student meeting Satisfactory Academic Progress Policy requirements.

Eligibility Requirements

To be eligible to receive aid from institutional, state, and federal need-based programs, an applicant must meet the following eligibility requirements: enroll or accepted for enrollment as a degree-seeking student; be a U.S. citizen or an eligible non-citizen; submit a complete FAFSA; and meet the Financial Aid Satisfactory Academic Progress Policy for Title IV recipients. Full-time enrollment is required for the majority of federal, state, and institutional programs. Students should consult with a financial aid advisor to determine how financial aid will be impacted for less than full time enrollment.

Federal Title IV Programs

The FAFSA is the application for all federal financial aid programs.

Federal Work-Study Program: This federal program provides employment opportunities to students with demonstrated financial need. Eligible undergraduate and graduate students are limited to 20 hours of work per week while classes are in session. All Federal Work-Study Program jobs pay at least minimum wage.

Federal Direct Loan Programs: This federal program encompasses Federal Subsidized, Unsubsidized, Graduate PLUS, and Parent PLUS Loans.

- Federal Subsidized and Unsubsidized Loans are long-term; low-interest loans guaranteed by the federal government for the educational expenses of eligible students enrolled at least half-time. Repayment begins six months after the student ceases at least half-time enrollment.
- Federal Parent PLUS Loans are available to parents of undergraduate dependent students enrolled at least half-time. Parents may borrow up to the cost of attendance minus any financial aid for which the student qualifies. You must apply at www.studentloans.gov and an approved credit check is required.
- Federal Graduate PLUS Loans provide additional loan funds to graduate students that have exhausted eligibility in the Federal Unsubsidized Student Loan Program. You must apply at **https://studentloans.gov** and an approved credit check is required.

Federal Pell Grant Program: Federal Pell Grants are awarded to undergraduate students with high financial need. This program is intended to provide grant support to lower income families. Students must be pursuing a first bachelor's degree to receive the Federal Pell Grant.

Federal Supplemental Educational Opportunity Grant: Virginia Tech awards this federal grant to undergraduate students with extraordinary financial need. These funds are restricted to Pell-eligible students.

Commonwealth of Virginia Programs

Virginia Guaranteed Assistance Program: Grants of up to the cost of tuition and fees are awarded by Virginia Tech from funds administered by the State Council of Higher Education for Virginia. Awards are made to eligible undergraduate residents of Virginia with demonstrated financial need. The list of requirements for this grant are available on our website.

Commonwealth Award: Awards are made by Virginia Tech from funds administered by the State Council of Higher Education for Virginia to Virginia residents seeking a first bachelor's degree with demonstrated financial need. The list of requirements for this grant are available on our website.

Two-Year College Transfer Grant: The Two-Year College Transfer Grant is administered by the State Council of Higher Education for Virginia. These grants are for undergraduate state residents who transfer from a community college with a 3.0 Grade Point Average (GPA) after completing an Associate's Degree at a Virginia two-year public institution. Recipients must maintain a 3.0 GPA and meet other requirements listed on our website.

The Virginia Military Survivors and Dependent Education Program: The Virginia Military Survivors and Dependents Education Program provides tuition and fee educational assistance for a maximum of 8 semesters or four academic years to spouses and children of military service members killed, missing in action, taken prisoner, or who became at least 90 percent disabled as a result of military service in an armed conflict. This program was formerly named the Virginia War Orphans Education Program. To be eligible for assistance, application is made to the Virginia Department of Veterans Services.

Academic Scholarships and Grants: Merit based scholarships are for select undergraduate students who establish outstanding an academic record, including incoming freshmen, through the academic department. Please refer to the scholarship section of our website for additional information. USFA offers the General Scholarship application through the electronic Scholarship Central Portal at **https://finaid.vt.edu**. This application is available August 1 and **the deadline is January 22.**

Athletic Scholarships: Admission and enrollment of students who are candidates for financial aid for which

athletic ability is a consideration shall be conditional upon compliance with applicable regulations of the Atlantic Coast Conference and the National Collegiate Athletic Association.

Veterans Affairs Educational Benefits (GI Bill): Applicants who wish to receive VA Educational Benefits, including assistance through the Yellow Ribbon Program should contact the Office of Veterans Services or visit **www.veterans.vt.edu**. Application information for veterans' benefits may be obtained from the nearest regional office of the Veterans' Administration. Students must enroll for a minimum of 12 credits each term to receive benefits as full-time students.

Additional Information

Additional information on financial aid and scholarships may be obtained by contacting:

The Office of University Scholarships and Financial Aid
Student Services Building, Suite 200
Virginia Tech
800 Washington Street SW
Blacksburg, VA 24061
Phone: (540) 231-5179
Fax: (540) 231-9139
E-mail: **finaid@vt.edu**
Website: **https://finaid.vt.edu**

All information is correct at the time of publication. Current information is available from the **Office of University Scholarships and Financial Aid** website.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

General Information

Mission of the University

Inspired by our land-grant identity and guided by our motto, Ut Prosim (That I May Serve), Virginia Tech is an inclusive community of knowledge, discovery, and creativity dedicated to improving the quality of life and the

human condition within the Commonwealth of Virginia and throughout the world.

Athletics, Intramurals, and Recreational Facilities

Virginia Tech has a diverse and highly active athletic program for men and women students in intercollegiate, intramural, and extramural sports. The athletic program is recognized as one of the most successful in the nation because it is geared to meet the needs of all students interested in physical and recreational sports activity.

The university has extensive and modern athletic and recreational facilities, including: Cassell Coliseum, an indoor arena seating 9,900; Lane Stadium, seating 65,632; a fully equipped recreation gymnasium, including War Memorial Pool; Rector Field House; Burrows-Burleson Tennis Center; English Baseball Field; outdoor tennis courts; the Pete Dye River Course of Virginia Tech and Virginia Tech Golf Course; Johnson/Miller Track Complex; Thompson Field for Soccer/Lacrosse; Tech Softball Park; a pond for ice skating in the winter; and the South Recreation Field Area for outdoor sports.

Virginia Tech's athletic varsity teams compete at the Division I level of the National Collegiate Athletic Association (NCAA). The university participates in the Atlantic Coast Conference for all varsity sports. Athletic scholarships are available in the following intercollegiate sports:

- Baseball (men)
- Basketball (men and women)
- Football (men)
- Golf (men)
- Lacrosse (women)
- Soccer (men and women)
- Softball (women)
- Swimming/Diving (men and women)
- Tennis (men and women)
- Indoor/Outdoor Track/Cross Country (men and women)
- Volleyball (women)
- Wrestling (men)

The following extramural sports clubs also are available: baseball (men's), basketball, bowling, clay target, competitive cheerleading, crew, cricket, cycling, equestrian, fencing, golf, women's field hockey, gymnastics, ice hockey, lacrosse, roller hockey, rugby, soccer, softball (women's), snow skiing, tennis, triathlon, volleyball, water polo, and wakeboard.

Virginia Tech offers a wide range of intramural and recreational programs for men and women including the following sports: basketball, billiards, bowling, chess, dodgeball, fantasy football, flag football, hearts tournament, racquetball, golf , innertube water polo, kickball, soccer, softball, swimming, table tennis, tennis, team darts, ultimate frisbee, volleyball, wallyball, and wiffleball.

Venture Out provides fun, safe, and educational outdoor services to the university community. Venture Out specializes in low-risk outdoor adventures, quality rental gear at unbeatable rates, and valuable resource materials. Venture Out is a healthy recreational alternative and allows the university community to enjoy all that Southwest Virginia has to offer, from hiking and camping, to kayaking, horseback riding, mountain biking, and skiing.

Venture Out
Phone: (540) 231-4982
E-mail: ventureout@vt.edu
Web: **www.recsports.vt.edu/content/venture-out**

Cadet System

The Virginia Tech Corps of Cadets is one of only two programs in the United States offering a corps of cadets within a large public university. **The Corps of Cadets**, a militarily structured organization, offers many leadership development opportunities to both male and female students. The Rice Center for Leader Development offers a minor in leadership studies. Contact Dr. Elaine Humphrey, Director, (540) 231-9455 for additional information on the center.

The Corps is supervised by the Commandant of Cadets, who establishes overall policies and methods of operation for the Corps. The cadet commanders and staff officers are responsible for implementation of policies and procedures.

Membership in the Corps involves a 24-hour-a-day commitment. Members wear a distinctive Virginia Tech cadet uniform and live in designated cadet residence halls. Both cadets and non-cadets are part of one student body, attend the same classes, and are organized into one student government. Cadets participate in all university activities, including athletics, social events, and cultural programs. Membership in the Cadet Regimental Band, the "Highty-Tighties," is restricted to cadets. Although many benefits are available through participation in one of the three ROTC programs offered at Tech, a student does not have to enroll in an ROTC program to be a member of the Corps of Cadets.

Career and Professional Development

Career and Professional Development works with students of all academic levels and all majors to assist with the following:

- **Making career decisions and plans.** Whether students are trying to decide on an academic major or a career field, Career Advisors on staff are ready to assist. Self-assessment tools are used to help students identify their unique strengths, interests, values, and personality type. Students can find a variety of career information through the Career and Professional Development web site (**www.career.vt.edu**) and in the Career Resource Library in the Smith Career Center.
- **Gaining career-related experience while in school.** Increasingly, employers expect students to have experience in their chosen field before graduation. In addition to administering the Cooperative Education and Internship Program (detailed below), Career and Professional Development provides hundreds of internship job listings through Handshake, their on-line resume referral database and job listing service, and sponsors one job fair in the fall and the Connection Job Far each spring semester.
- **Determining post-graduation career plans.** This typically involves seeking full-time employment or applying to graduate or professional school. Career and Professional Development offers a full range of services related to educating students about the job search process including resume and cover letter critiques, practice interviews, seminars on business etiquette, and more. Through the Handshake system, students have access to thousands of job listings and opportunities to connect with employers through the On-Campus Interviewing Program. Additionally, Health Professions Advising is located within Career and Professional Development and is dedicated to assisting students who are interested in continuing their education to pursue a health related occupation.

Information about all of Career and Professional Development's resources, services and programs - including an events calendar - is located at **www.career.vt.edu**. To meet with a Career Advisor to discuss any of these topics, students can schedule an appointment through Handshake, by calling (540) 231-6241, or by visiting Career and Professional Development during 10-minute drop-in hours, Monday - Friday, 11:00am. - 3:00pm. Career and Professional Development is located in the Smith Career Center on the corner of Washington Street and West Campus Drive.

Cooperative Education & Internship Program

The Cooperative Education & Internship Program (CEIP) is an academic program that provides students the opportunity to combine real world work experience with classroom theory. It involves one or more semesters or summers of paid or unpaid, full-time or part-time work, and is a partnership among the student, Career and Professional Development, the academic department, and the employer. Gaining career-related experience

gives the cooperative education or internship student the opportunity to test career goals, develop key experiences and skills, defray the costs of a college education, and gain an important edge for the post-graduation job market. The VT student transcript will indicate Cooperative Education and Internship enrollment during the term(s) worked.

The CEIP, as a student learning experience with guidance and supervision of a faculty member, includes an orientation for all students who plan to enroll in the Cooperative Education & Internship Program as well as a reflection exercise at the end of the experience. CEIP orientations are scheduled throughout the year and are designed to expose students to professional competencies required at work and walk them through enrollment in one of two courses that will guide them while away from campus. To find out more about the program, please call (540) 231-6241 or visit **https://career.vt.edu/experience/ceip.html**.

Requirements for participation in the Cooperative Education and Internship Program

These are the two courses that will guide the student experience while they are at work, CEP 4084 for full time experiences (32 to 40 hours per week) and CEP 3084 for part time work experiences (4 to 31 hours per week). The Cooperative Education and Internship Program will enroll the student in the appropriate course. Both courses include the following:

- Both are for undergraduate students with a GPA of 2.0 or higher
- Students can begin work after their freshman year
- Work can be paid or unpaid
- The course will appear on the transcript with zero-academic-credit
- The course does not include credit hour costs, but does have a $75 fee attached for each semester enrolled
- Grading: Completion of requirements yields a grade of S (Satisfactory). Non-completion of requirements yields a grade of NS (Non-Satisfactory)
- Student status is maintained when enrolled in either program
- Can enroll for a single term or multiple terms
- Advisors in the student's academic department will approve the work-term timing to ensure the student stays on track to take academic courses when needed

Additional Notes

- The Cooperative Education and Internship Program is open to undergraduates in any major.
- To see where our current students are working, visit **https://db.career.vt.edu/reports/EmployersListByMajor.php**
- The Graduate School administers the graduate Cooperative Education and Internship Program.

Counseling Center (Thomas E. Cook Counseling Center)

240 McComas Hall, 107 East Eggleston Hall, and 202 S. Main Street (Kent Square)

The Thomas E. Cook Counseling Center is accredited by the International Association of Counseling Services and provides a full range of mental health services to all undergraduate and graduate students on the Blacksburg campus and the Roanoke (Riverside I) campus. Services include crisis intervention, individual and group counseling, and psychiatric care. Cook Counseling Center also offers consultation services for students, parents, faculty, and staff; 24/7 after-hours emergency on-call services; mental health outreach including peer assistance programs; and online screenings.

The Cook Counseling Center consists of a multidisciplinary staff and all services are provided under the direction of licensed, credentialed and experienced mental health professionals and support staff. Confidentiality is an essential aspect of the counseling relationship between Cook Counseling Center staff and students. Confidentiality in the counseling relationship is protected by ethical principles and under legislative code in the Commonwealth of Virginia; information shared in counseling may only be released with the written permission of the student.

Through the provision of mental health services, the Cook Counseling Center provides opportunities for students to learn more about themselves as individuals, form deeper relationships with their peers, and grow to benefit our community and society-at-large. Cook staff members are aware of and respect cultural, individual, and role differences, including those based on age, gender, gender identity, race, ethnicity, culture, national origin, religion, sexual orientation, gender expression, disability, language, and socioeconomic status and consider these factors when working with students.

The Cook Counseling Center services are covered by payment of the student health fee. An appointment can be made by calling (540) 231-6557 or stopping by the office located in 240 McComas Hall.

Cook Counseling Center | 540-231-6557 | ucc.vt.edu | counseling@vt.edu

Cultural and Community Centers

As a department within Student Affairs, Cultural and Community Centers' programs, policies, and personnel create the conditions for underrepresented student success and to develop the cultural competence of every Virginia Tech student. We achieve this mission through advocacy, advising, and awareness.

Cultural and Community Centers hosts six centers, all located in the Squires Student Center. Students of every culture are encouraged to visit the centers and engage in conversation. The centers are:

- American Indian and Indigenous Community Center (AIICC)
- Asian Cultural Engagement Center
- Black Cultural Center
- El Centro Hispanic/Latino Center
- Intercultural Engagement Center
- LGBTQ+ Resource Center

Cultural and Community Centers' hosts a Community Kick-Off each fall to welcome students, faculty, and staff in identity-based communities, history and heritage months, and cultural achievement ceremonies each spring.

In addition, our team is available to provide informal advising to any student or student organization that feels they might fit within the scope of our mission.

Through programs and events, Cultural and Community Centers increases awareness of underrepresented students' experiences and develops opportunities to gain cultural competence for every Virginia Tech Student.

Cultural and Community Centers | 540-231-8584 | ccc.vt.edu | vtccc@vt.edu

Dean of Students Office

The Dean of Students office serves as advocates for students and their support networks in times of personal, academic, and community crisis.

We know that life doesn't stop while students are in college. When life throws challenges in students' way, we're here to help them create plans, connect to resources, and gain the confidence to get back on track. We work with students, families, friends, and faculty. We're a friendly, caring team ready to listen and assist. We welcome referrals, appointments, and walk-ins.

A member of the Dean's Staff is on-call 24 hours a day, seven days a week. Between the hours of 8 a.m. and 5 p.m., call the Dean of Students office at 540-231-3787. After hours, the on-call staff member from Dean's Staff may be reached by calling the Virginia Tech Police at 540-231-6411, press 1.

Dean of Students | 540-231-3787 | dos.vt.edu | dean.students@vt.edu

First-Year Experiences

Virginia Tech's signature first-year experience (FYE) initiative includes courses specific for first time first-year and transfer students. Each course is designed to enhance the student experience within the major through focus in the discipline(s) and emphasis on fostering the abilities of the students to:

- Problem solve
- Explore and use information appropriately and effectively, and
- Integrate ideas and experiences and apply them to new learning situations within and beyond campus.

The programmatic goal is to provide experiences that will enhance the students' ability to thrive in the first year and beyond through:

- Advising and mentoring students,
- Connecting campus community,
- Fostering inclusivity,
- Supporting ethical use of information,
- And demonstrating effective teaching practice

A description of each program with contact information can be found at **http://www.fye.vt.edu**.

Global Travel Insurance & Emergency Assistance

Under University Policy 1070, http://www.policies.vt.edu/1070.pdf , all Virginia Tech students participating in university supported global travel are required to carry international medical and emergency assistance insurance. To meet this requirement, the university has contracted with an insurance provider CISI.

Some of the benefits of the Cultural Insurance Services International (CISI) policy include:

- Security & Natural Disaster Evacuation
- Repatriation
- Emergency Medical expenses, medical evacuation, & medical reunion

Those traveling internationally in a group for a formal education and study abroad program should refer to the Virginia Tech Global Education website at **https://www.globaleducation.vt.edu** for insurance requirements.

Those traveling internationally on Virginia Tech business, not in a study abroad program, should refer to Virginia Tech Risk Management website at **http://risk.controller.vt.edu/vi/international.html**.

Honor Code and Honor System

The Honor Code is the university policy which defines the expected standards of conduct in academic affairs. The Virginia Tech Honor Code embodies a spirit of mutual trust and intellectual honesty that is central to the very nature of the university and represents the highest possible expression of shared values among the members of the university community.

The fundamental beliefs underlying and reflected in the Honor Code are: that trust in a person is a positive force in making that person worthy of trust, that every student has the right to live in an academic environment that is free from the injustices caused by any form of intellectual dishonesty, and that the honesty and integrity of all members of the university community contribute to its quest for truth.

The functions of the Honor System are to communicate the meaning and importance of intellectual honesty to all students of the university; to articulate and support the interest of the community in maintaining the highest standards of conduct in academic affairs; and to identify, sanction, and educate those who fail to live up to the stated expectation of the university community with regard to these standards. (Please see the "**Academics**" section of this catalog for details relating to the Honor Code and System.)

Information Technology

Information Technology supports computing and communications including voice and data communications, instructional technologies, administrative processing, software support, high performance research computation, and individual help and tutorials. The website **www.computing.vt.edu** is a guide to specific services and support.

The data network provides rapid access to email, class materials, library databases, and to the Internet for every resident in university housing. Wireless network access is available in most academic and administrative spaces across campus. Wireless facilitates mobility across the campus and, in conjunction with the university computer requirement for laptops, tablet computers, and software, is used in the classroom setting to improve the effectiveness of teaching and learning.

Virginia Tech is committed to using information technology to enhance teaching and learning and works to ensure that teaching faculty members have the ability to use information technology effectively. Instructional faculty members have continuing opportunities to engage with emerging technologies and to practice with both established and emerging technologies to achieve enhanced learning outcomes for students. Information Technology supports learning experiences through the online Scholar course management system, online course evaluations, and support for video production and distribution for both on-campus and distance learning classes. The required undergraduate student software bundle and other instruction-related software are offered at favorable pricing to students.

Direct support to students in information technology is provided through the 24x7 help resource, 4Help (**www.4help.vt.edu**). No-cost loans of over a hundred different pieces of equipment are offered through InnovationSpace (**www.is.vt.edu**). These include video cameras, still cameras, audio recorders, iPads, lighting, microphones, and tripods, on-site use of video and audio editing software, various drawing tablets, and scanning devices. Classes on this hardware and software are free through iLearn workshops (**www.ilearn.is.vt.edu**). Computer labs offer additional options for collaboration and for access to highly specialized software. Each student is provided an email account and access to file space for storage or websites.

My VT (**www.my.vt.edu**) provides secure access to personal information, including course materials, one's own contact information, and billing and account information. Security of this and other information is overseen by the Information Technology Security Office (**www.security.vt.edu**), protected through careful maintenance of strong passwords and online credentials, and incorporated into development of new applications.

Information Technology facilitates undergraduate, graduate, and faculty research through high performance networks and high performance computing, as well as through on-going professional development support, acquisition of specialized research software, and collaborative research.

For more on the Information Technology organization, see **www.it.vt.edu**.

Living and Dining On-Campus

Housing and Residence Life

Virginia Tech's Housing and Residence Life operates 47 on-campus residence halls housing more than 9,300 residents. Our goal is to provide inclusive communities, foster a culture of learning, offer safe, clean, well-maintained living environments, and provide exceptional service.

A residence hall is more than just a place to sleep. The on-campus experience is enriched by the initiatives and engagement of our resident student staff and our professional and para-professional staff who live in the residence halls. We have three faculty principals living within residential colleges and many other faculty involved in the residential colleges and other living-learning communities.

To support such a dynamic environment, HRL has a complete facilities operation that includes maintenance, housekeeping, lock shop, renovations, fire and safety compliance, and warehousing. Occupancy management oversees assignments and contracting, resident communications, and general services.

All first-year students live on campus unless they fall into one of the following categories: those living with parents or other close relatives, those who are married and living with their spouses, veterans of at least six months of military service, or those who are at least 21 years old. Written requests for exceptions to this policy should be directed to Housing and Residence Life in 144 New Hall West, (0428).

Campus housing is also available, but not guaranteed, for other students. Transfer and graduate/professional students may request housing through an online wait list. A lottery-style housing application process is held each spring to allocate residential space to returning undergraduate students who wish to live on campus.

Housing and Residence Life | 540-231-6205 | housing.vt.edu | housing@vt.edu

Virginia Tech Off-Campus Housing

Virginia Tech Off-Campus Housing (VTOCH) provides students with resources, programs, and services to assist with their off-campus housing needs including a comprehensive searchable online database. a wonderful resource to begin. VTOCH maintains information on local apartments, realtors, transportation, and issues affecting renters today. VTOCH hosts two housing fairs each year so students can get up close and personal with rental options and roommate fairs so students can make connections with others to share living expenses.On the VTOCH website, users can find detailed information about people looking for or offering housing, ways to research housing options, roommates, furniture for sale, or ride requests. VTOCH also provides detailed information about apartment and realty companies in the Blacksburg area.

Twice each year, in the fall and in the spring, VTOCH hosts the Virginia Tech Off-Campus Housing Fair, where students, faculty, staff, and community members are able to interact with local property managers to view options for the following academic year. Additionally, other important housing-related companies will be in attendance, so guests can have conversations about their rights and responsibilities as tenants, renters insurance, utilities, and town relations. If you plan to move off-campus or just wants to see what your options are, plan to attend this once-a-semester free event.

Virginia Tech Off-Campus Housing | 540-231-3466 | www.campuslife.vt.edu/vtoch/ | vtoch@vt.edu

Dining Services

Virginia Tech has built a reputation for outstanding dining. Our dining program remains at the leading edge of national trends and maintains a tradition of award-winning events, programs, venues, and service. Students report high overall satisfaction and appreciate the variety of dining options available on campus. Recent customer comments such as "I brag about our food service to my friends and family" illustrate that Virginia Tech students share our pride in the dining program. Extensive online information on nutrition, special diets, and food allergies helps students plan their eating.

With more than 19,000 dining plan holders, Dining Services serves approximately 7.5 million meals per year, with total on-campus sales of $65 million annually.

Numerous dining options are available for both on-campus and off-campus students, as well as for faculty, staff, and campus visitors. All on-campus residents choose an individual Major, Mega, or Premium Flex Plan. Off-campus students may select one of six individual dining plans or participate in the Dining Dollars program. More than 11,000 off-campus students opt to have a dining plan each year.

Dining at Virginia Tech is anything but traditional. The award-winning dining program specializes in preparing diverse menus in innovative, exciting venues:

- **Au Bon Pain** operates dining venues in three campus locations.
    - Au Bon Pain in the Squires Food Court at Squires Student Center serves distinctive bakery items, upscale sandwiches, and signature soups.
    - Au Bon Pain at the Graduate Life Center serves many of the same bakery and sandwich options, as well as grab-n-go items, as the cafe in Squires Student Center. This location serves students living and studying in the Graduate Life Center.
    - Au Bon Pain at Goodwin Hall offers students on the academic side of campus a dining option that

serves many of the same items as the location in Squires Student Center.

- **Burger '37** in the Squires Food Court at Squires Student Center offers gourmet beef, turkey, and vegetarian burgers, hand-cut fries, and classic shakes.
- **D2** at Dietrick Hall takes traditional dining to the next level by combining all-you-care-to-eat dining with the variety of an international marketplace and includes a shop dedicated to gluten-free, vegetarian, and vegan specialties.
- **Deet's Place** at Dietrick Hall is a gourmet coffee, ice cream, and pastry shop, complete with award-winning coffee beans roasted in-house.
- **DXpress** at Dietrick Hall is perfect for a quick snack on the run, such as biscuits, burgers, and pizza by the slice, and is open until 2:00a.m. for late-night options.
- **Hokie Grill & Co.** at Owens Hall features national brands Chick-fil-A, Pizza Hut, and Dunkin' Donuts, in addition to Blue Ridge Barbecue, grab-n-go sandwiches, snacks, salad, and fruit bar.
- **Owens Food Court** at Owens Hall consists of 12 specialty shops serving international and American favorites, including carved-to-order meats, a soup and salad bar, burgers, pastas, Philly cheese steaks, tacos, and a venue that serves exclusively local, organic, or sustainably produced foods.
- **Turner Place** at Lavery Hall offers a variety of convenient options to the academic side of campus. It houses franchises for Jamba Juice, Bruegger's Bagels, and Qdoba Mexican Grill alongside five upscale original venues serving sushi, crepes, gelato, teppanyaki, southern steakhouse fare, sourdough pizza, custom salads, and much more.
- **Vet Med Cafe** at the Virginia-Maryland Regional College of Veterinary Medicine on Duck Pond Drive and offers breakfast and lunch, Monday through Friday. Breakfast features breakfast bagel sandwiches and hot oatmeal, and lunch offers a daily chef special as well as grilled fish tacos and more.
- **West End Market** at Cochrane Hall features wood oven-baked pizzas, wraps, grilled steaks, seafood, homemade pastas, made-from-scratch soups, freshly baked pastries and breads, and more - all prepared right before your eyes.

Dining Services | 540-231-3933 | www.dining.vt.edu | dining@vt.edu

Location

The main campus is located in Blacksburg, Virginia, about 38 miles southwest of Roanoke, Virginia. To reach the campus from Interstate 81, take Exit 118-B (Christiansburg) onto U.S. Rt. 460 West. To reach the Visitor and Undergraduate Admissions Center, continue on U.S. 460 for 8.5 miles to the Prices Fork Road exit for "Downtown." Turn right at the first traffic light on Prices Fork Road and then take an immediate right and up the drive to the center.

Detailed Directions to Virginia Tech and Campus Map

Multicultural Academic Opportunities Program

The Multicultural Academic Opportunities Program (MAOP), founded in 1993 is an academic success community founded upon the principles of self-efficacy, mentoring, and peer support. Central to the goal of MAOP is the promotion of diversification within the student body of Virginia Tech. Through partnerships with various academic colleges and departments at Virginia Tech, other colleges and universities, governmental entities, and various organizations, MAOP participants are supported with academic guidance, social and emotional support, and financial support.

The MAOP community is open to all students who demonstrate a clear commitment to the pursuit of academic excellence and are interested in the promotion of diversity in an ever global community. MAOP provides opportunities for both undergraduate and graduate students through scholarships, tuition/assistantship support, academic workshops, and undergraduate research opportunities.

Web: **http://www.maop.vt.edu**
Phone: (540) 231-5023

Parking Regulations

All vehicles, including motorcycles and scooters, parked on the Virginia Tech campus must be registered with the Parking Services Office and must display a university parking permit. Yearly, semester, summer, and daily parking permits are available and an appropriate fee is charged for each permit. Visitors are required to display a visitor permit, which is available at the Virginia Tech Visitor Information Center. For more information about parking or to request a parking regulations handbook, visit **www.parking.vt.edu** or call (540) 231-3200.

Alternative Transportation

The Alternative Transportation Program offers several options for commuter students to get to class without the hassles of parking permits and searching for parking spaces through the Commuter Alternatives Program (CAP).

CAP has two programs to fit your commuting needs.

- Carpool Program: Carpooling saves you money on parking and gas, and it's the closest thing you can get to RESERVED PARKING on campus.
- BB&W is available to commuter students who use alternative transportation methods as their primary means of commuting to campus. Examples include riding the Blacksburg Transit or SmartWay buses, bicycling, and walking. By registering for BB&W, you will receive 15 half price daily parking passes per semester.

Bicycles can be registered for free through Parking Services at **www.parking.vt.edu**.

For more information about commuter alternatives visit **www.tcs.vt.edu/alternative** or call (540) 231-0248.

ROTC Program

The Reserve Officer Training Corps Programs conducted at Virginia Tech are available to cadets and are offered by the Army, Navy/Marine Corps, and the Air Force. All students participating in ROTC are required to be members of the Corps of Cadets. Details about courses offered, as well as available scholarships and stipends, can be found in the department listings under the College of Liberal Arts and Human Sciences; ROTC (Army), ROTC (Navy/Marine Corps), and ROTC (Air Force). Upon successful graduation from Virginia Tech and completion of the ROTC program, the student is commissioned as an officer in either an active or reserve component of the Armed Forces. The total ROTC credits applied toward degree requirements varies by major and ranges from four to 24. All credits count as free electives. Consult your course advisor for information on ROTC credits, which may be used within your major.

Students interested in additional details should contact the professor of military science for Army ROTC, the professor of naval science for Naval/Marine Corps ROTC, or the professor of aerospace studies for the Air Force ROTC program.

General Rules Governing the Cadet Lifestyle

All Virginia Tech students are eligible to join the Cadet Regiment and participate in the cadet lifestyle. Cadet student status is a prerequisite for participation in any of the ROTC programs. Students that want to be a cadet, but not in ROTC can enroll in the Citizen-Leader Track, or VP1617 UG Catalog Template.dwt Battalion. VPI Battalion cadets live in the same cadet dorms, wear the same uniforms, and hold the same leadership positions, but go directly into private and public sector careers when they graduate.

Physical Standards: The Department of Defense has prescribed physical standards for formal enrollment in the ROTC programs. Cadets not physically qualified for an ROTC program may remain in cadet status as members of the Corps of Cadets.

Cadet Regulations: Cadets are expected to adhere to the Cadet Honor Code and abide by all cadet regulations, directives, policies, and procedures of the Corps, as well as the rules governing civilian students.

The following summary gives the prospective cadet an understanding of the nature of his or her obligation as a cadet:

- Cadet officers and non-commissioned officers are responsible to university authorities for the activities of the cadets under their supervision and are given the authority to discharge their responsibilities.
- Cadet residence halls are coeducational with controlled visiting privileges for non-residents and mandatory quiet study periods.
- Alcoholic beverages are prohibited in the cadet residence halls.
- Cadets are required to wear the cadet uniform to classes and cadet functions.
- Cadets are required to live in a designated cadet residence hall unless married and living with a spouse.
- Second-semester freshmen and upperclassmen in the corps may request a change to civilian status at any time. First-semester new cadets may not leave the corps and change to civilian status until the last day to drop a class without penalty (after six weeks of class). All students are encouraged to make status changes (from cadet to civilian lifestyle or vice versa) in conjunction with the beginning or end of an academic semester.

See **Academics** section for details on the ROTC course credits that apply toward degrees.

For Additional Information:

Commandant of Cadets	**Air Force ROTC**	**Army ROTC**	**Naval/Marine Corps ROTC**
Lane Hall, Room 141 280 Alumni Mall	Military Building, Room 228 320 Stanger Street	Military Building, Room 228 320 Stanger Street	Femoyer Hall, Room 417 280 Stanger Street
Virginia Tech	Virginia Tech	Virginia Tech	Virginia Tech
Blacksburg, VA 24061	Blacksburg, VA 24061	Blacksburg, VA 24061	Blacksburg, VA 24061
(540) 231-6413	(540) 231-6404	(540) 231-6401	(540) 231-7883
corpsofcadets@vt.edu	usaf@vt.edu	rotc@vt.edu	usnavy@vt.edu

Services for Students with Disabilities

Services for Students with Disabilities (SSD) serves students who have or think they may have disabilities. The department provides numerous accommodations, programming to promote disability awareness and community engagement, and resources for students with disability and temporary injuries or illnesses. SSD partners with Student Affairs and campus stakeholders to ensure students with disabilities are connected to resources necessary for equal participation and access to University services. Students who think they may have a disability are encouraged to contact SSD to learn more about our services and reasonable accommodations. Whether it's a question about sign-language interpretation, reasonable accommodations, or obtaining an emotional support animal, SSD is available to help students transition to and actively participate in University life. Contact us by phone, email, or stop by and visit us in the office.

Services for Students with Disabilities
Lavery Hall, Suite 310
430 Old Turner St
Blacksburg, VA 24061

ssd@vt.edu
540-231-3788

ADA and University Policy

In compliance with Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA) of 1990, and with the ADA Amendments Act of 2008, Virginia Tech is committed to ensuring that all qualified students with disabilities have the opportunity to pursue a postsecondary education without barriers to instruction and services. Under Policy Memorandum 178 and university Policy 4075, the university has given authority to Services for Students with Disabilities (SSD) to interpret disability documentation, determine the existence of a disability, and determine appropriate accommodations in this university setting. Academic accommodations, as determined by SSD, serve to "level the playing field" by removing barriers between students with disabilities and students who do not have a documented disability.

Student Affairs

Student Affairs at Virginia Tech is committed to the growth, development, and achievement of students at Virginia Tech. This organization works closely with academic colleagues to support students as they learn to be successful and effective leaders in the emerging global community. The mission of the Student Affairs is to promote student learning, life skills, and personal growth through a strong focus on holistic student development and collaborative partnerships that deliver superior service to, and care for, students in the spirit of Ut Prosim.

We want students to have an exceptional college experience at Virginia Tech, and our excellent academic programs are a great start. Recognizing that learning happens both in and out of the classroom, Student Affairs facilitates experiences and offers resources students need to graduate as successful, educated, and reflective individuals. Through Student Affairs programs, events, and services, students can hone their skills as responsible leaders, discover and pursue promising careers, develop habits for healthy and fulfilling lives, and make a tangible, positive impact on the communities to which they belong.

Student Affairs | http://www.students.vt.edu/ | 540-231-6272 | studentaffairs@vt.edu

Aspirations for Student Learning

Our philosophy is grounded in the Aspirations for Student Learning. The five Aspirations for Student Learning are our best hopes for and expectations of our students. Embracing these Aspirations helps Virginia Tech students find and define themselves through intentional reflection on all they are learning.

- Commit to unwavering CURIOSITY
  Virginia Tech students will be inspired to lead lives of curiosity, embracing a lifelong commitment to intellectual development.
- Pursue SELF-UNDERSTANDING and INTEGRITY
  Virginia Tech students will form a set of affirmative values and develop the self-understanding to integrate these values into their decision-making.
- Practice CIVILITY
  Virginia Tech students will understand and commit to civility as a way of life in their interactions with others.
- Prepare for a life of COURAGEOUS LEADERSHIP
  Virginia Tech students will be courageous leaders who serve as change agents and make the world more humane and just.
- Embrace UT PROSIM as a way of life
  Virginia Tech students will enrich their lives through service to others.

ExperienceVT

Student Affairs helps students explore, practice, and live the Aspirations for Student Learning by offering opportunities they might pursue while at Virginia Tech—from internships, career fairs, and engagement in student organizations, to intramural sports, leadership development, and everything in between. Your engagement with activities outside the classroom will make you an accomplished, marketable, and self-aware community citizen, exhibiting transferable skills valued by employers. By attending events and programs, taking part in clubs and organizations, reflecting on your experiences, and tracking your progress, Virginia

Tech students can capture the pivotal moments in their lives as Hokies.

This complete list of Student Affairs departments with direct links is available online at students.vt.edu.

- Advancement
- Assessment and Professional Development
- Communications
- Cook Counseling Center
- Corps of Cadets
- Cranwell International Center
- Cultural and Community Centers
- Dean of Students
- Dining Services
- Family Relations
- Finance
- Fraternity and Sorority Life
- Hokie Wellness
- Housing and Residence Life
- Human Resources
- Information Technology
- Learning Partnerships
- New Student and Family Programs
- Recreational Sports
- Schiffert Health Center
- Services for Students with Disabilities
- Student Conduct
- Student Engagement and Campus Life
- VT Engage

A detailed statement of the rights and responsibilities of students is contained in the University Policies for Student Life.

Student Engagement and Campus Life

Through Student Engagement and Campus Life (SECL), you can get involved with student, organizations, your student unions, leadership development, leisure and recreation, and student employment. This department within Student Affairs complements the academic experience and enriches the quality of student life at Virginia Tech. SECL cultivates innovative environments and communities to provide transformative experiences for all Hokies. Student learning through engagement and employment are major tenants of our mission. . SECL strives to assist students in developing an appreciation for diversity, responsibility for self-learning, critical thinking, and pragmatic skills to become life-long learners, productive citizens, and community leaders.

The department is responsible for the support of our 800+ student organizations as well as the advisement of the Student Budget Board, which provides funding, registration, and support to student organizations.

Student Engagement and Campus Life | 540-231-5431 | campuslife.vt.edu | stuact@vt.edu

Student Clubs and Organizations/GobblerConnect

With more than 800 **registered student organizations** and about 60 new clubs every year, there are plenty of options for students to get involved. They include Greek letter organizations, military clubs, service groups, academic study groups, religious organizations, cultural organizations, and more.

GobblerConnect is the portal to getting involved in any and everything here at Virginia Tech. Through it,

students can learn about different clubs and organizations discover the latest events, programs, and news occurring on campus, and exchange information with other engaged Hokies.

GobblerConnect | 540-231-5431 | www.gobblerconnect.vt.edu | gobblerconnect@vt.edu

Student Centers

Squires (located off Alumni Mall) and **Johnston Student Centers** (located behind Burruss Hall) are hubs of activity for the university community. They serve as formal and informal meeting places for students, student organizations, and the larger university community. Facilities include meeting rooms, conference rooms, ballrooms, and theaters. Plenty of comfortable space welcomes students. Services such as banking and ATMs can be found in these student centers, as well as a variety of dining options. Many departments call Squires Student Center home. We house the New Student Programs, the music department, student media, student organization offices, Cultural and Community Centers, a non-denominational meditation space, and Student Legal Services. Students, faculty, staff, and guests are free to use Squires or Johnston to meet with friends, study, attend activities and events, or just hang out.

Squires Student Center Information Desk | 1st Floor Squires Lobby | 540- 231-6906
Johnston Student Center Information Desk | 1st Floor Johnston | 540-231-5266

The Graduate Life Center at Donaldson Brown (located on Otey Street, across from Squires) is an innovative living-learning facility that supports Virginia Tech's goals for graduate education. The GLC features plenty of study space, a coffee shop, an auditorium, and a multipurpose conference room for graduate and undergraduate students.

GLC Information Desk | 1st floor GLC lobby | 540- 231-0413

The War Memorial Chapel stands prominently at the end of the Drillfield. It is the only Chapel on campus and provides a nondenominational place of solitude and meditation for all. It is host to religious services, weddings, baptisms, prayer vigils, memorial services, initiations, military commissioning, music recitals, student vocal and ministry groups, concerts, lectures, individual prayer and meditation, and bible study.

War Memorial Chapel | 540-231-6240

Event Planning
221 Squires Student Center
Phone: (540) 231-5005
E-mail: eventplanning@vt.edu
Web: **www.campuslife.vt.edu/eventplanning/index.html**

The Information Services Center in Squires is staffed with knowledgeable students employees who are ready to answer questions about your student centers, student activities, the university, and the surrounding community. The Information Services Center is where you can learn more about events, get maps and bus schedules, or look for lost and found articles.

The Squires Information Desk
1st floor Squires lobby
Phone: (540) 231-6906
E-mail: stuact@vt.edu

The Perspective Gallery presents art exhibitions by diverse artists working in a variety of media and styles. Visitors can view work of local and regional artists, nationally recognized artists, and artisans from around the world. Receptions and special events allow the public to meet and talk with the artists. Perspective Gallery is located on the second floor of Squires Student Center. Admission is always free. You can also enjoy works in the permanent collection, located throughout the public areas in Squires and Johnston Student Centers and the Graduate Life Center.

Perspective Gallery
2nd floor Squires Student Center

Phone: (540) 231-4053
Web: **www.campuslife.vt.edu/perspectivegallery/index.html**

The Production Services Office is a full service production company for campus events. Production Services offers professional lighting, sound, staging, and rigging. The staff works one-on-one with clients to ensure event production expectations are met.

Production Services
128 Squires Student Center
Phone: (540) 231-3499
E-mail: production.services@vt.edu

The Recital Salon and Studio Theater, home for events sponsored by the School of the Performing Arts, are located on the second floor of Squires. Exciting and eclectic concerts and theater performances by students, faculty, and visiting artists are held throughout the year. Contact the Squires Ticket Office or Information Services Center for more information.

The Student Engagement and Campus Life Ticket Office is the major ticket distribution center for events other than athletics at Virginia Tech. The office supports ticket sales for theatrical and musical performances, concerts, lectures, and movies.

Student Engagement and Campus Life Ticket Office
129 Squires Student Center
Phone: (540) 231-5615 or 800-843-0332
Web: **www.campuslife.vt.edu/tickets/index.html**

Virginia Tech Off-Campus Housing (VTOCH), provides students with resources, programs, and services to assist with their off-campus housing needs including a comprehensive searchable online database. a wonderful resource to begin. VTOCH maintains information on local apartments, realtors, transportation, and issues affecting renters today. VTOCH hosts two housing fairs each year so students can get up close and personal with rental options and roommate fairs so students can make connections with others to share living expenses.

Virginia Tech Off-Campus Housing
Johnston Student Center, 3rd floor
E-mail: vtoch@vt.edu
Web: **www.campuslife.vt.edu/vtoch/index.html**

Recreation

The BreakZONE Recreation Center is the place to go to relieve the stress of classes and tests! The BreakZONE sponsors competitive leagues, on-site skills classes, and open play in a variety of activities. An expanded line-up includes pool tables, bowling lanes, table tennis, foosball, and video games. Students, faculty, staff, and guests can enjoy testing their skills while relaxing with friends in an upbeat environment.. BreakZONE also sells snacks and beverages. Get in the ZONE!

BreakZONE
117 Squires Student Center
Phone: (540) 231-4476
Web: **www.campuslife.vt.edu/breakzone/index.html**

Student Centers

Squires (located off Alumni Mall) and **Johnston Student Centers** (located behind Burruss Hall) are hubs of activity for the university community. They serve as formal and informal meeting places for students, student organizations, and the larger university community. Facilities include meeting rooms, conference rooms, ballrooms, and theaters. Plenty of comfortable space welcomes students. Services such as banking and ATMs can be found in these student centers, as well as a variety of dining options. Many departments call Squires Student Center home. We house the Intercultural Engagement Center, New Student Programs, , the music

department, student media, student organization offices, VetZone, a non-denominational meditation space, and Student Legal Services, and numerous cultural centers. Students, faculty, staff, and guests are free to use Squires or Johnston to meet with friends, study, attend activities and events, or just hang out.

Squires Student Center Information Desk
1st Floor Squires Lobby
Phone: (540) 231-6906

Johnston Student Center Information Desk
1st Floor Johnston
Phone: (540) 231-5266

The Graduate Life Center at Donaldson Brown (located on Otey Street, across from Squires) is an innovative living-learning facility that supports Virginia Tech's goals for graduate education. The GLC features plenty of study space, a coffee shop, an auditorium, and a multipurpose conference room for graduate and undergraduate students.

GLC Information Desk
1st floor GLC lobby
Phone: (540) 231-0413

The War Memorial Chapel stands prominently at the end of the Drillfield. It is the only Chapel on campus and provides a nondenominational place of solitude and meditation for all. It is host to religious services, weddings, baptisms, prayer vigils, memorial services, initiations, military commissioning, music recitals, student vocal and ministry groups, concerts, lectures, individual prayer and meditation, and bible study.

War Memorial Chapel
Phone: (540) 231-6240

Student Employment

Student Engagement and Campus Life offers a variety of student employment opportunities to compliment your academic pursuits, afford resume-building experience, and provide income. We are committed to the development and advancement of student employees through leadership and career skills training. In all we do, our main goal is to provide customer service to the patrons of our facilities and programs. Join us today and work in YOUR student center!

Student Employment
225 Squires Student Center
Phone: (540) 231-5431
Web: **www.campuslife.vt.edu/employment/students/index.html**

The administrative offices are located on the second floor of Squires Student Center in room 225. The office is open from 8a.m. to 5p.m. Monday through Friday. Please contact us for any information regarding StudentEngagement and Campus Life .

Student Engagement and Campus Life Administrative Office
225 Squires Student Center
Phone: (540) 231-5431
E-mail: stuact@vt.edu
Web: **www.campuslife.vt.edu/index.html**

Student Health Services and Insurance

On-Campus Health Center (Schiffert Health Center, McComas Hall)

Upon payment of the health fee and submission of a completed physical examination form, students are eligible for the services provided by the **Schiffert Health Center** on campus. Located in McComas Hall, the Schiffert Health Center offers medical care similar in scope to that given by general practitioners. Facilities

include an inpatient ward, pharmacy, and x-ray equipment. A professional staff of nurses, technicians, and physicians is available to assist students.

The health services fee paid to the university, however, does not constitute medical insurance. This fee only provides for any minor care administered by the Schiffert Health Center staff.

Student Health History

Each student entering Virginia Tech must furnish an immunization history packet, completed by a home physician, for the Schiffert Health Center. The form is available online to applicants who accept the offer of admission. Failure to meet the health services standards may result in dismissal from the university.

The Online Student Health Portal is your gateway to reviewing your immunization compliance, submitting documentation, and filling out your Medical History Questionnaire. Before you can access this portal, you will need a Virginia Tech PID and PID password. If you do not know this information, please contact Virginia Tech's 4-HELP at 540-231-4357. The Online Student Health Portal is available at **https://osh.healthcenter.vt.edu**.

Schiffert Health Center | 540-231-6444 | www.healthcenter.vt.edu | healthcenter@vt.edu

Student Medical Insurance Coverage

The university has contracted with a health insurance carrier to offer group health coverage for full-time students at Virginia Tech. For details on coverage and specific benefits, please contact the Student Medical Insurance office at 540/ 231-6226 or visit **http://risk.controller.vt.edu/studentmedicalinsurance.html**.

Health insurance is mandatory for international students with F-1 or J-1 visas, all Virginia Tech Carilion School of Medicine, and all College of Veterinary Medicine students. All students with a mandatory insurance requirement must provide written verification from their insurer that they have coverage that meets the minimum requirements set by the University as outlined on the waiver form found at **http://risk.controller.vt.edu/studentmedicalinsurance.html** or they must purchase the university-sponsored plan or another health insurance plan meeting or exceeding the University outlined minimum coverage levels. Review of insurance policies and completion of the waiver form must be done by the student's insurer at the student's request. Once the waiver form is completed by the student's insurer, the university will determine if the insurance coverage meets the outlined minimum requirements.

University at a Glance

Since its founding as a land-grant college in 1872, Virginia Tech has grown to an enrollment of about 35,000. With approximately 280 degree programs and managing a research portfolio of more than $531 million, Virginia Tech offers the widest range of degree choices in Virginia and is the state's leading research institution.

The university offers about 110 bachelor's degree programs through its seven undergraduate academic colleges: the College of Agriculture and Life Sciences, the College of Architecture and Urban Studies, the Pamplin College of Business, the College of Engineering, the College of Liberal Arts and Human Sciences, the College of Natural Resources and Environment, and the College of Science. On the postgraduate level, the university offers about 170 master's and doctoral degree programs through the Graduate School, Virginia-Maryland College of Veterinary Medicine, and the Virginia Tech Carilion School of Medicine.

Virginia Tech pushes the boundaries of knowledge by taking a hands-on, transdisciplinary approach to preparing students to be leaders and problem-solvers. The university fulfills its role as a land-grant by fostering a collaborative environment that integrates technology into all disciplines, so that the Virginia Tech community can serve as a force for positive change around the commonwealth, the country, and the world.

Through experiential learning, future-focused research, and an inclusive, spirited culture, Virginia Tech strives to accomplish the charge of its motto *Ut Prosim* (That I May Serve).

In the research arena, seven research institutes draw upon established strengths and enhance the university's

ability to address large-scale research opportunities by crossing traditional disciplinary and college boundaries. These institutes are: the Fralin Life Sciences Institute at Virginia Tech; Fralin Biomedical Research Institute at VTC; Hume Center; Institute for Creativity, Arts, and Technology; Institute for Critical Technology and Applied Science; Institute for Society, Culture, and Environment; and Virginia Tech Transportation Institute.

University Exemplary Departments

University Exemplary Department Awards recognize the work of departments that maintain, through collaborative efforts of dedicated colleagues, exemplary teaching and learning environments for students and faculty.

University Facilities

Virginia Tech has more than 235 campus buildings, research laboratories, an airport, a 2,600-acre main campus in Blacksburg, a 1,800-acre research farm in Montgomery County, and facilities across the commonwealth.

Among the university's major facilities in Blacksburg are: Carol M. Newman Library, with more than 2.3 million volumes; the Moss Arts Center, home of the Center for the Arts at Virginia Tech professional presenting program; The Inn at Virginia Tech and Skelton Conference Center, which offers conference space and 147 hotel rooms and suites; Cassell Coliseum (seating 10,000); and Lane Stadium (seating more than 66,000). Adjacent to campus is the Virginia Tech Corporate Research Center, which employs more than 3,000 and offers businesses the opportunity to establish close working relationships with the university.

Major facilities outside of Blacksburg include the Innovation Campus in Northern Virginia, now under development; the Steger Center for International Scholarship and Architecture in Switzerland; the Virginia Tech Northern Virginia Center in Falls Church; the Hotel Roanoke & Conference Center; public radio station WVTF, which covers a large part of Virginia; the Marion duPont Scott Equine Medical Center in Leesburg; Virginia Tech Research Center - Arlington; the Washington-Alexandria Center of the College of Architecture and Urban Studies; the Virginia Tech Carilion School of Medicine and Fralin Biomedical Research Institute in Roanoke; Tech Center Research Park in Newport News, Virginia; 11 agricultural experiment stations; and six 4-H centers.

University Libraries

A member of the prestigious Association of Research Libraries, the University Libraries consist of the Carol M. Newman Library and three branches: Art and Architecture, Veterinary Medicine, and the Northern Virginia Resource Center located in Falls Church, Virginia. Their online services are available 24/7.

The libraries offer services and resources to support students in their work every step of the way. From visiting the information services desk on the second floor for help with a research project, to using our **3D printing studio** for course projects, to simply using our spaces for quiet our collaborative work, students can find numerous resources at the libraries.

Newman Library is home to many hands-on spaces that allow experiential learning, such as **Fusion Studio** for longer term collaborative projects. Students can also seek help with writing papers and other projects at the English department's Writing Center, or assistance preparing for presentations at the communication department's CommLab, both on the second floor. Other library studios include **Media Design**, **Data Visualization**, **Data Transformation**, and **Virtual Environments**. The Libraries' Digital Humanities and Social Sciences program – **Athenaeum** – provides support to courses and research projects in these disciplinary areas.

Help can be found on our **homepage**, and many resources, including our **Ask A Librarian chat**, online collections, and **subject research guides**, can be used from anywhere on or off campus, without stepping foot in our buildings.

In each of the libraries, there is a Circulation/Reference desk staffed by people who can help you locate and use resources. Each college and academic department also has a **librarian who is a subject expert** and can help you find relevant research, suggest journals, or point you in the direction of resources for your area of study.

Special Collections, located on the first floor of Newman Library, houses major research collections including the Archives of American Aerospace Exploration, the International Archive of Women in Architecture, Railroad Archives, the Culinary History Collection, and many items from the Civil War.

For users with disabilities, there is a Special Services Room in Newman Library equipped with adaptive software and hardware.

For additional information, check out **www.lib.vt.edu**, come walk through our spaces, or stop by one of the help desks.

Veterans Services

The Office of Veterans Services is the primary resource for Virginia Tech veterans and their dependents. Staff work closely with the Department of Veterans Affairs to receive and process all documentation related to veteran and military student educational benefits. The Office of Veterans Services works closely with The Student Success Center to ensure veterans, military students and dependents are connected to the resources necessary for a successful transition to and through their course of study at Virginia Tech. In collaboration with The Student Success Center, students served by the Office of Veterans Services have access to tutoring, mentoring, assistance navigating the VA system, and the Veterans@VT student organization.

130 Student Services Building (mc 0548)
Blacksburg, VA 24061
Phone: (540) 231-5815
E-mail: veteran@vt.edu
Web: **www.veterans.vt.edu**

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Governance, Administration, and Faculty

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Deborah L. Petrine, Vice Rector
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Appointed by the Governor to terms expiring on dates indicated.

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C. T. Hill (2015-19)
Anna L. James (2017-2021)
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Mehmood Kazmi (2015-19)
L. Chris Petersen (2016-20)
Deborah L. Petrine (2011-19)
Michael J. Quillen (2014-18)
Wayne H. Robinson (2014-18)
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Faculty (A-Z)

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Faculty (A-Z)

A

ABAID, Nicole T. (2012), Assoc. Prof. of Mathematics. B.S., North Carolina, 2003; M.A., Kansas, 2008; Ph.D. Polytechnic Institute of New York, 2012.

ABAYE, A. Ozzie (1992), Prof. of Crop and Soil Environmental Sciences. B.S., Wilson College (PA), 1984; M.S., Penn State, 1987; Ph.D., Virginia Tech, 1992.

ABBAS, Montasir (2005), Prof. of Civil and Environmental Engineering. B.S. Univ. of Khartoum (SUDAN), 1993; M.S. Univ. of Nebraska-Lincoln, 1997; Ph.D., Purdue Univ., 2001, P.E.

ABBATE, Janet (2004), Assoc. Prof. of Science, Technology, and Society. B.A., Harvard-Radcliffe College, 1985; M.A., Univ. of Pennsylvania, 1988; Ph.D., Univ. of Pennsylvania, 1994.

ABBOTT, A. Lynn (1990), Professor of Electrical and Computer Engineering. B.S., Rutgers, 1990; M.S., Stanford, 1981; Ph.D., Illinois, 1989.

ABEYSEKARA, Ananda (1999), Assoc. Prof., Dept. of Religion and Culture. B.A. Macalester College,1992; M.A. University of Virginia, 1994; Ph.D, Northwestern Univ., 1999.

ABPLANALP, Bill (2014), Director of Information Technology and Data Administration, B.S., Virginia Tech, 2001, M.B.A., Virginia Tech, 2005.

ABRAHAMS, Alan S. (2007), Associate Professor of Business Information Technology. B.S., Cape Town, 1997; Ph.D., Cambridge, 2002.[10]

ABRAHAMSON, Zachary R. (2013), Database & Applications Admin I. B.S., Radford University., 2009.

ACAR, Pinar (2018), Assistant Professor of Mechanical Engineering, B.Sc., Astronautical Engineering, Istanbul Technical Univ., 2010; M.Sc., Aerospace Engineering, Istanbul Technical Univ., 2012; Ph.D., Aerospace Engineering, Istanbul Technical Univ., 2013; Ph.D., Aerospace Engineering, Univ. of Michigan, 2017.

ACHENIE, Luke E.K. (2007), Prof. of Chemical Engineering. B.S., Massachusetts Institute of Technology, 1981; M.S., Northwestern, 1982; M.A.M., Carnegie Mellon, 1984; Ph.D., Carnegie Mellon, 1988.

ACITO, Andrew A. (2019), Asst. Prof. of Accounting and Information Systems. B.S., Indiana, 2002; Ph.D., Iowa, 2011.

ADAMS, Colin S. (2015), Asst. Prof. of Aerospace and Ocean Engineering. B.S., University of Washington, 2005; M.S. University of Washington, 2009; Ph.D. University of New Mexico, 2015.

ADAMS, David R. (2009), Director, Learning Systems Integration and Support. B.S., Missouri State Univ., 1998.

Adams, Lucas, J. (2019) Asst. Prof. of Aerospace Studies, Air Force ROTC. 2014 Bachelor of Science degree in Resource Management, Virginia Tech, Blacksburg, Virginia; 2015 Aircraft Maintenance Officer Course, Sheppard Air Force Base, Texas; 2017 Master of Arts in Christian Ministry Leadership, Liberty University, Lynchburg, Virginia

ADAMS, M. Norris (2008), Clinical Asst. Prof. of Surgery and Lameness, Marion duPont Scott Equine Medical Center. B.S., Cornell Univ., 1988; D.V.M., Mississippi State Univ., 1992; Diplomate A.C.V.S., 1999.

ADAMS, Zach (1990), Assistant Director Occupational Safety and Health Programs for Environmental Health and Safety. B.S. Virginia Tech, 1985.

ADJERID, Idris (2018), Associate Professor of Business Information Technology. B.A., Virginia Tech, 2005; M.B.A., Virginia Tech, 2008; Ph.D., Carnegie Mellon University, 2013.

ADJERID, Slimane (1998), Prof. of Mathematics. B.S., University of Algiers, 1979; M.S., Rensselaer Polytechnic Institute, 1982; Ph.D., Rensselaer Polytechnic Institute, 1985.

AGAH, Masoud (2005), Virginia Microelectronics Consortium Professor of Electrical and Computer Engineering. B.S in EE, Sharif Univ. of Technology, Tehran, Iran, 1996; BS EE, Sharif Univ. of Technology, 1998; Ph.D., Univ. of Michigan, 2005.

AGMON, Danna (2012), Assoc. Prof. of History. B.A., Tel Aviv Univ., 2003; M.A., Univ. of Michigan, 2007; Ph.D., Univ. of Michigan, 2011.

AGOZINO, Onwubiko, (2009), Prof. of Sociology and Africana Studies. B.S., Univ. of Calabar-Nigeria, 1985; M.Phil., Univ. of Cambridge, UK, 1990; Ph.D., Univ. of Edinburgh, 1993.

AGUD, Diane B. (1993), Senior Instructor of Mathematics. B.A., Molloy College, 1985; M.A., St. John's University, 1990.[4]

AHMADIAN, Mehdi (1995), Dan Pletta Professor of Mechanical Engineering. B.S., SUNY, Buffalo, 1980; M.S., SUNY, Buffalo, 1982; Ph.D., SUNY, Buffalo, 1984.

AHMED, S. Ansar (1989), Associate Dean for Research and Graduate Studies. B.Sc., Bangalore (India), 1972; B.V.Sc., UAS (India), 1977; Ph.D., Murdoch U. (Perth, Australia), 1985.

AIDI, Bilel (2017), Instructor of Biomedical Engineering and Mechanics. B.S., National School of Engineering of Sfax, 2010; M.S., National School of Engineering of Sfax, 2011; Ph.D., Virginia Tech, 2016.

ALEXANDER, Kathleen A. (2007), Professor in Fish and Wildlife Conservation. B.S., Univ. of California-Davis, 1988; D.V.M., Univ. of California-Davis, 1992; Ph.D., Univ. of California-Davis, 1995.

ALEXANDER, Michael D. (1972), Prof. of Education. B.S., Western Ky., 1966; Ed.D., Indiana, 1969.

ALLEN, Barbara (2000), Prof. of Science, Technology, and Society; Assoc. Director of Science and Technology Studies and Director of the Graduate Program in STS, National Capital Region. B.S., Univ. of Colorado, Boulder, 1976; M.S., Columbia, 1977; Ph.D., Rensselaer Polytechnic Institute, 1999.

ALLEN, Blair J. (2016), Systems Developer, Pamplin College of Business.

ALLEN, Irving C. (2012) Assoc. Professor, Department of Biomedical Sciences and Pathobiology. B.S., East Carolina University., 1997; M.S., The University of North Carolina at Greensboro, 2000; Ph.D., The University of North Carolina at Chapel Hill, 2006.; MBA, North Carolina State University, 2012.

ALLEN, Katherine R. (1989), Prof. of Human Development. B.S., Univ. of Connecticut, Storrs, 1976; M.A., Syracuse, 1980; Ph.D., Syracuse, 1984.

ALLEN, Kylie (2018), Assistant Professor of Biochemistry. B.S., Eastern Washington University, 2007; Ph.D., Washington State University 2013.

ALLNUTT, Robin (2002), Senior Instructor of English. B.A., Virginia Tech, 1987; M.F.A., George Mason University, 1997.

AMATEIS, Patricia G. (1996), Assoc. Prof. of Chemistry. B.S., Concord College, 1979; Ph.D., Virginia Tech, 1984.[2,3,4,7]

ALBRIGHT, Kathryn C. (1994), Associate Dean of Academic Affairs and Prof. of Architecture. B.Arch., Virginia Tech, 1982; M.Design Studies, Harvard, 1994.

ALEXANDER, Diana Y. (2015), Cost Accounting Manager. B.S., Virginia Tech, 2007; C.P.A.

ALEXANDER, W. Nathan (2016), Asst. Prof. of Aerospace and Ocean Engineering. B.S., Virginia Tech, 2007; M.S., Virginia Tech, 2009; Ph.D., Virginia Tech, 2011.

ALMOND, Lynn A. (2010), Asst. Prof. of Practice of Accounting and Information Systems. B.S., Virginia Tech, 1977; Master of Accountancy, Virginia Tech, 1988.

ALWANG, Jeffrey R. (1989), Professor of Agricultural and Applied Economics. B.A., Penn State, 1978; M.S., Penn State, 1985; Ph.D., Cornell, 1987.

AMACHER, Gregory S. (1994), Julian N. Cheatham Professor of Forest Economics. B.S., Pennsylvania State,

1984; M.A., Michigan, 1989; M.A., Michigan, 1990; M.S., Michigan, 1991; Ph.D., Michigan, 1993.

AMBROSONE, John A. (2004), Associate Professor of Theatre. B.A., State University of New York at Fredonia, 1983; M.F.A., Virginia Tech, 1986.

AMELINK, Catherine (2009), Assistant Provost for Learning Systems Innovation and Effectiveness. B.A., James Madison University, 1987; M.S., James Madison University, 1988; Ph.D., Virginia Tech, 2005.

AMPADU, Paul (2016), Professor of Electrical and Computer Engineering. B.S., (Highest Honors) Electrical Engineering, Tuskegee University, 1996; M.S., Electrical Engineering, University of Washington, 1999; Ph.D., Electrical and Computer Engineering, Cornell University, 2004.

ANDERSON, Angela (2018), Collegiate Assistant Professor of Human Nutrition, Foods and Exercise. B.S. Pacific Lutheran University 1997; Ph.D. Virginia Tech 2013.

ANDERSON, Lara B. (2013), Asst. Prof. of Physics. B.S., Utah State Univ., 2003; M.S., Utah State Univ., 2004; Ph.D., Univ. of Oxford, UK, 2008.

ANDERSON, Susan G. (1982), Senior Instructor of Mathematics. B.S., Mary Washington, 1980; M.S., Virginia Tech, 1982.

ANDRANGO-WALKER, Catalina (2011), Assoc. Prof. of Spanish. B.A., U of Missouri-Columbia, 2002; M.A., Washington U, St. Louis, 2004; Ph.D., Washington U, St. Louis, 2009.

ANGERMEIER, Paul L. (1988), Professor in Fish and Wildlife Conservation, and Asst. Leader, Coop. Fish and Wildlife Research Unit. B.S., Purdue, 1976; M.S., Illinois, 1979; Ph.D., Illinois, 1982.

ANING, Alexander O. (1992), Assoc. Prof. of Materials Science and Engineering. B .S., Morgan State Univ., 1976; Ph.D., Univ. of Missouri-Rolla, 1982.

ANSELL, Aaron (2012), Assoc. Prof., Dept. of Religion and Culture. B.A., University of California San Diego, 1999; M.A., University of Chicago, 2002; Ph.D., University of Chicago, 2007.[12]

APODACA, Clair (2012), Assoc. Prof. of Political Science. B.A., San Diego State U, 1990; M.A., Purdue U, 1992; Ph.D., Purdue U, 1996.

ARACHCHIGE, Shamindri M. (2010), Advanced Instructor of Chemistry. B.Sc., Open Univ. of Sri Lanka; Ph.D., Wayne State Univ., 2006.

ARAMAN, Philip A. (1992), Adjunct Senior Research Scientist of Wood Science and Forest Products. B.S., North Carolina State, 1968; M.S., VPI&SU, 1975.

ARAV, Nahum (2007), Assoc. Prof. of Physics. B.S., Univ. of Tel Aviv, 1990; Ph.D., Univ. of Colorado, 1994.

ARCHIBALD, Thomas G. (2013), Associate Professor of Agricultural, Leadership, and Community Education. B.S., Cornell Univ., 2002; M.S., Cornell Univ., 2012; Ph.D., Cornell Univ., 2013.

ARDITTI, Joyce A. (1989), Prof. of Human Development. B.S., Univ. of Georgia, 1980; M.A., Univ. of Connecticut, 1982; Ph.D., Univ. of North Carolina, Greensboro, 1988.

ARENA, Christopher (2017), Collegiate Asst. Professor of Biomedical Engineering and Mechanics. B.S., Univ. of Virginia, 2008; Ph.D., Virginia Tech, 2013.

ARENA, Sara (2017), Collegiate Asst. Professor of Biomedical Engineering and Mechanics. B.S., Virginia Tech 2007; M.S., Virginia Tech, 2008; Ph.D., Virginia Tech, 2011.

ARENDSE, Avril U. (2016), Clinical Instructor of Small Animal Clinical Sciences. B.S., George Mason Univ., 1999; DVM, Tuskegee Univ, 2003; Diplomate, ACVIM.

ARMSTRONG, Amanda (2018), Academic Advisor, Pamplin College of Business. B.A., Mars Hill University,

2010; M.A., Appalachian State University, 2014.

ARMSTRONG, Amaryah (2019), Asst. Prof., Dept. of Religion and Culture. B.A., Belmont University, 2010; M.T.S., Emory University, 2012; Ph.D. Vanderbilt University, 2019.

ARMSTRONG, Elizabeth A. (2013), Director, Scholarships and Financial Aid. B.A., Indiana University, 1995; M.S., Indiana University, 2004.

ARMSTRONG, Mark R. (1995), Senior Instructor of English. B.A., Davidson College, 1977; M.A., University of North Carolina-Greensboro, 1985; Ph.D., University of North Carolina-Greensboro, 1996.

ARNOLD CHRISTIAN, Susan R. (2010), Asst. Director of the Center for the Enhancement of Engineering Diversity, Engineering. B.S. Kansas State University, 1996, M.S., University of Nebraska, 2009.

ARNOLD, Rachel (2012), Collegiate Asst. Prof. of Mathematics. B.S., Virginia Tech, 2006; M.S., Virginia Tech, 2008; Ph.D., Virginia Tech, 2012.

AROGO OGEJO, Jactone (2005), Assoc. Prof. of Biological Systems Engineering. B.S., Univ. of Nairobi, Kenya, 1983; M.S., Illinois, 1989; Ph.D., Illinois, 1997.

ARSENAULT, Rhonda K. (2001), Assoc. Vice President for Advancement Services. B.A., Univ. of Illinois at Urbana-Champaign, 1990; M.S., Univ. of Illinois at Urbana-Champaign, 1992.

ARTHUR, Craig (2016), Head, Foundational Instruction and Community Engagement; Library. B.A., Virginia Tech, 2006; M.L.I.S., University of North Carolina at Greensboro, 2012.

ARTHUR, Jeffrey B. (2000), Assoc. Prof. of Management. B.S., Univ. of California, Santa Cruz, 1983; M.S., Cornell Univ., 1987; Ph.D., Cornell Univ., 1990.

ARTHUR, Nikeshia (2015), Assistant Director Civil Rights Compliance. B.A., Virginia Tech, 2007; JD, College of William and Mary School of Law, 2010.

ARTIS, Pat (2018), Prof of Practice of Aerospace and Ocean Engineering. B.S., Virginia Tech, 1971; M.S., Rutgers University, 1976; Ph.D., University of Pretoria, 1992.

ASBECK, Alan (2015), Assistant Professor of Mechanical Engineering. B.S., Electical Engineering, MIT, 2002; B.S., Physics, MIT, 2003; M.S., MIT, 2003; Ph.D., Stanford Univ., 2010.

ASFAW, Teffera (2013), Instructor of Mathematics. B.Sc., Asmara University, Asmara, Ethiopia, 1990; M.Sc., Addis Ababa University, Addis Ababa, Ethiopia, 2000; Ph.D., University of South Florida, 2013.

ASHKAR, Rana (2017), Asst. Prof. of Physics. B.S., Lebanese Univ., 2003; M.S., American Univ. of Beirut, 2007; Ph.D., Indiana Univ., 2012.

ASHLEY, Richard A. (1981), Prof. of Economics. B.S., Cal Tech, 1971; M.S., California (San Diego), 1972; Ph.D., California (San Diego), 1976.

ASKEW, Shawn D. (2001), Assoc. Prof. of Weed Science. B.S. Mississippi State Univ., 1995; M.S., Mississippi State Univ., 1997; Ph.D. North Carolina State Univ., 2001.

ASSAD, Lisa Marie (2015), Financial Reporting Manager. B.A., Radford Univ, 1991; M.ACCT, Virginia Tech, 1994; C.P.A.

ASRYAN, Levon V. (2004), Assoc. Prof. of Materials Science and Engineering. M.S., Yerevan State Univ., 1985; Ph.D., Ioffe Institute (St. Petersburg, Russia), 1988; Dr.Sci., Ioffe Institute of Physics and Technology (St. Petersburg, Russia), 2002.

ATHANAS, Peter M. (1992), Professor of Electrical and Computer Engineering. B.S., Toledo, 1983; M.S., Rensselaer, 1985; S. M., Brown, 1990; Ph.D., Brown, 1992.

AUGUSTE, Jonathan A. (2017), Asst. Prof. of Entomology. BS, Univ of West Indies, Trinidad, 2006; PhD, Univ. of West Indies, Trinidad, 2011.

AUST, W. Michael (1989), Professor of Forestry. B.S., Mississippi State, 1982; M.S., Mississippi State, 1985; Ph.D., North Carolina State, 1989.

AUSTIN, Elisabeth (2007), Assoc. Prof. of Spanish. B.A., William & Mary 1996; M.A., U Pennsylvania 2000; Ph.D., U Pennsylvania, 2006.

AVEY, Paul C. (2015), Asst. Prof. of Political Science. B.A., Univ. of Iowa, 2005; M.A., Univ. of Chicago, 2006; M.A., Univ. of Notre Dame, 2010; Ph.D., Univ. of Notre Dame, 2013.

AWATE, Kiran S. (2018), Asst. Prof. of Management. B.S., Univ. of Pune, India, 1997; M.B.A., Indian Institute of Management, Bangalore, 2011; Ph.D., The Ohio State Univ., 2018.

AXSOM, Danny K. (1987), Associate Professor of Psychology. B.A., University of Virginia, 1977; M.A., Princeton University, 1979; Ph.D., Princeton University, 1984.

AYLWARD, Frank O. (2017), Asst. Prof. of Systems Biology. B.S., Univ. of Arizona, 2008; Ph.D., Univ. of Wisconsin, 2013.

AZANO, Amy P. (2012), Assoc. Prof. of Education. B.A., Louisiana State Univ., 1994; M.S.Ed., Old Dominion Univ., 1997; Ph.D., Univ. of Virginia, 2009.

B

BABB, William M. (2015), Deputy Chief of Police and Assistant Director of Security. B.A., Roanoke College, 1990; M.A., American Military Univ., 2010.

BACK, Godmar (2004), Assoc. Prof. of Computer Science. B.S., Technical Univ. of Berlin, 1994; Ph.D., Univ. of Utah, 2002.

BADGLEY, Brian D. (2012), Asst. Prof. of Crop and Soil Environmental Sciences. B.S. Univ. of Georgia 1995; M.S. Univ. of Maryland 2002; Ph.D. Univ. of South Florida 2009.

BADINELLI, Ralph D. (1985), Ralph Medinger Lenz Professor in Business. B.S., Hofstra, 1974; M.S., Purdue, 1976; M.S., Purdue, 1978; Ph.D., Purdue, 1982.

BAGCHI, Rajesh (2008), Richard E. Sorensen Junior Faculty Fellow and Prof. of Marketing. M.S., Univ. of Cincinnati, 2000; Ph.D., Univ. of Colorado, Boulder, 2008.

BAHEL, Eric A. (2009), Assoc. Professor of Economics. B.S., Institute of Statistics and Applied Economics (ISSEA), 2002; M.S., Université d'Auvergne, 2004; PhD. Université de Montréal, 2009.

BAI, Xianming (David) (2016), Assist. Prof. of Materials Science and Engineering. B.S. & M.S., Fudan Univ., 2000; M.S., Johns Hopkins Univ., 2001; Ph.D., Georgia Inst. of Tech., 2006.

BAILEY, Annette (2005), Assistant Director, Electronic Resources & Emerging Technology Svcs; Library. B.A., North Carolina State University, 1996; M.L.I.S., Univ. of Illinois at Urbana-Champaign, 2001.

BAILEY, Scott (2006), Professor of Electrical and Computer Engineering. B.S., Virginia Tech, 1990; M.S., Univ. of Colorado, 1994; Ph.D., Univ. of Colorado, 1995.

BAIN, Carolyn U. (2004), Director, Alumni Relations. B.S., High Point Univ., 1996.

BAIRAKTAROVA, Diana (2015), Asst. Prof. of Engineering Education. B.S., Technical Univ. of Sofia, 1991; M.S., Technical Univ. of Sofia, 1993; M.B.A., Hamline School of Business, 2009; Ph.D., Purdue, 2013.

BAIRD, Donald G. (1978), Alexander F. Giacco Prof. of Chemical Engineering. B.S., Michigan State, 1969;

M.S., Michigan State, 1971; Ph.D., Wisconsin, 1974.

BAIRD, Timothy D. (2012), Asst. Prof. of Sustainability. A.B., Bowdoin College, 1999; M.A., Univ. of North Carolina, 2007; Ph.D., Univ. of North Carolina, 2012.

BAKELEY, Avery (2018), Assistant Director for Education, Outreach and Conflict Resolution. B.S., Virginia Tech, 1991; J.D., University of Pittsburgh School of Law, 1994.

BAKER, Charlotte (2019), Assistant Professor. DrPH, MPH, CPH. Department of Population Health Sciences.

BAKER, Hannah (2014), Instructor of English. B.A., Kansas State University, 2011; M.A., Kansas State University, 2013.

BAKER, Jeri A. (2015), Director of Parking and Transportation. B.A., University of Texas, 2003.

BAKER, Joseph B. (2008), Assoc. Professor of Electrical and Computer Engineering. B.Sc., Univ. of New England, Australia, 1992; Ph.D., Univ. of Michigan, 2001.

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ZAMBRISKI, Jenni (2018), Assistant Professor of Department of Population Health Sciences. B.S., Tufts University, 2000; D.V.M., Tufts University, 2006; PhD, Cornell University, 2013.

ZANOTTI, Laura (2006), Prof. of Political Science. B.A., Univ. of Pavia, 1985; M.B.A., SCA Bocconi, 1988; Ph.D., Florida International U, 2004.

ZARE, Bonnie (2017). Assoc. Prof. of Women's and Gender Studies. B.A., Stanford University (1988); M.A., University of Wisconsin (1989); Ph.D., Tufts University (1994).

ZELLNER BASSETT, Paola (2010), Asst. Prof. of Architecture. M.Arch., Southern Calif. Inst. Architecture, 1998.

ZENG, Haibo (2014), Asst. Professor of Electrical and Computer Engineering. B.E., Tsinghua Univ., 1999; M.S., Tsinghua Univ., 2002; Ph.D., Univ. of California at Berkeley, 2008.

ZHANG, Bo (2013), Research Assistant Prof., Soybean Genetics and Breeding Specialist. B.S., Shenyang Agricultural Univ., 1998; M.S., Chinese Academy of Agricultural Sciences, 2003; Ph.D, Univ. of Arkansas, 2006.

ZHANG, Chenming (2001), Turner Fellow of Engineering, Prof. of Biological Systems Engineering. B.S., Univ. of Science and Technology, China, 1986; M.S., Univ. of Science and Technology, China, 1991; M.S., Iowa State, 1996; Ph.D. Iowa State, 1999.

ZHANG, Jinsuo (2017), Professor of Mechanical Engineering. B.S., Engineering Mechanics, Zhejiang Univ., 1997; Ph.D., Engineering Mechanics, Zhejiang Univ., 2001.

ZHANG, Liqing (2004), Assoc. Prof. of Computer Science. B.S., Lanzhou University, 1997; Ph.D., Univ. of California, 2002.

ZHANG, Ruiling (2013), Web Application Developer. M.A., Capital University of Economics & Business 1996; M.S. University of Minnessota, 1998; Diploma Mathmatics (An Yang Normal University, 1990.

ZHANG, Wencai (2019), Asst. Prof. of Mining and Minerals Engineering. B.S., Shandong University of Science and Technology, 2011; M.S. Central South University, 2013; Ph.D. University of Kentucky, 2017.

ZHANG, Wenwen (2018) Asst. Prof of Urban Affairs and Planning, B.E., Zhejiang University, 2011; S.M. Georgia Institute of Technology 2013; S.M. Georgia Institute of Technology 2013; S.M. Georgia Institute of Technology 2017; Ph.D., Georgia Institute of Technology 2017.

ZHANG, Yang (2008), Assoc. Prof. of Urban Affairs and Planning. B.S., Peking Univ., 1997; M.S., Peking Univ., 2000; Ph.D., Texas A&M Univ., 2006.

ZHANG Yanjin (2012). Associate Professor at University of Maryland. D.V.M., China, 1984; M.S., China, 1989; Ph.D., Iowa State University, 1998.

ZHANG, Zhiyang (2013), Instructor of Statistics. M.S., Sun Yat-Sen Univ., 2008; Ph.D., Virginia Tech, 2013; M.S., Virginia Tech, 2016.

ZHAO, Bingyu (2007), Assoc. Prof. of Horticulture. B.S., Qingdao Agricultural Univ., 1994; M.S., Chinese Academy of Agricultural Sciences, 1997; Ph.D., Kansas State Univ., 2004.

ZHAO, Tingting (2018), Asst. Prof. of Chinese. B.A., East China Normal U, 2008; Ph.D., Stanford, 2016.

ZHENG, Xiaoyu Rayne (2015), Assistant Professor of Mechanical Engineering. B.S. Applied Math, Beijing Univ. of Aeronautics & Astronautics, 2005; B.S. Mechanical Engineering, Beijing Univ. of Aeronautics & Astronautics 2005; PH.D., Boston University, 2011.

ZHOU, Wei (2015), Asst. Professor of Electrical and Computer Engineering. B.S., Shanghai Jiao Tong Univ., 2004; M.S., Shanghai Jiao Tong Univ., 2007; Ph.D., Northwestern Univ., 2012.

ZHOU, Ying (2006), Assoc. Prof. of Geophysics. B.S., Zhejiang Univ., China, 1996; M.S., Chinese Academy of Sciences, 1999; M.A., Princeton Univ., 2001; Ph.D., Princeton Univ., 2005.

ZHU, Haiyan (2009), Asst. Prof. of Sociology. B.S., Peking Univ., 1996; M.A., Peking Univ., 2000; M.A., Univ. of Michigan, 2004; Ph.D., Univ. of Michigan, 2008.

ZHU, Hongxiao (2014), Asst. Prof. of Statistics. B.S., Wuhan Univ., 2002; M.S., Univ. of Arkansas at Little Rock, 2004; Ph.D., Rice Univ., 2009.

ZHU, Huiyuan (2018), Asst. Prof. of Chemical Engineering. B.S., Univ. Science and Technology, Hefei 2009; M.A., Brown 2012; Ph.D., Brown 2014.

ZHU, Jinsong (2007), Associate Professor of Biochemistry. B.Sc., Wuhan Univ., 1989; Ph.D., Shanghai Institute of Plant Physiology, Chinese Academy of Sciences, 1994.

ZHU, Xiaoping (2017). Associate Dean and Department Chair at University of Maryland. D.V.M., China, 1984; M.Sc., China, 1987; Ph.D., University of Wisconsin-Madison, 1997.

ZHU, Yizheng (2012), Asst. Professor of Electrical and Computer Engineering. B.S., Tsinghua Univ., 1998; M.S., Tsinghua Univ., 2000; Ph.D., Virginia Tech, 2007.

ZHU, Yunhui (2016), Assistant Professor of Electrical and Computer Engineering. B.S., Physics, Peking University, 2007; Ph.D., Physics, Duke University, 2013.

ZICK, Stephanie E. (2016), Assistant Professor of Meteorology. B.S., Rutgers University, 2005; M.S., The Pennsylvania State University, 2007; Ph.D., University of Florida, 2013.

ZIEGLER, Peter (2009), Research Asst. Prof. of Academic Programs. B.A., Univ. of Montana, 1995; Ph.D., Cornell Univ., 2007.

ZIETSMAN, Lizette (2005). Assoc. Prof. of Mathematics. B.S., University of Pretoria, 1990; M.S., University of Pretoria, 1992; Ph.D., University of Pretoria, 2000.

ZIMMERMAN, Kurt (2004), Prof. of Biomedical Sciences and Pathobiology. D.V.M., Purdue, 1984; Ph.D., Virginia Tech, 2003; Diplomate, A.C.V.P.

ZIMMERMAN, Ryan D. (2013), Assoc. Prof. of Management. B.S., Univ. of the State of New York, 1996; M.B.A., Univ. of Iowa, 1999; Ph.D. Univ. of Iowa, 2006.

ZINK-SHARP, Audrey (1992), Professor of Wood Anatomy and Assoc. Department Head. B.S., Colorado State, 1983; M.S., Colorado State, 1986; Ph.D., SUNY-ESF, Syracuse, 1992.

ZOBEL, Christopher W. (1998), R.B. Pamplin Professor of Business Information Technology. B.A., Colgate University, 1991; M.S., University of North Carolina at Chapel Hill, 1993; Ph.D., UVa., 1998.

ZUO, Lei (2014), Professor of Mechanical Engineering. B.S., Tsinghua Univ., 1997; M.S., Mechanical Engineering, MIT, 2002; M.S., Electrical Engineering, MIT, 2002; Ph.D., MIT, 2005.

2019-2020 Undergraduate Course Catalog and Academic Policies

Honors College

Paul Knox, Dean
Joan Banks-Hunt, Instructor
Lefter Daku, Assistant Dean of Finance
Emily Harmon, Communications Specialist
Paul Heilker, Director of Experiential Learning
Neal Henshaw, Technical Director
Michelle Kovac, Program Manager
Michael Kretser, Collegiate Assistant Professor of Information Technology & Decision Sciences
Stephanie Lewis, Collegiate Assistant Professor
Christina McIntyre, Director of Professional Development, National and International Scholarships
Heather Nolen, Business Manager
Pamela Pack, Program Support Specialist
Russell Shrader, Director of Admissions and Scholarships
Sara Vandyke, Executive Director
Anne-Lise Velez, Collegiate Assistant Professor, College of Architecture and Urban Studies

Phone: 540-231-4591
Web: **www.honorscollege.vt.edu**

Our Mission

The mission of the Virginia Tech Honors College is to inspire and facilitate an extraordinary undergraduate education for students of exceptional motivation with a variety of life experiences. Honors students seek to be active learners and strive to apply their knowledge and skills to tackling critical real-world problems. To this end, the Honors College provides opportunities and presents challenges that foster meaningful and sustained relationships with faculty, independent learning, undergraduate research engagement, place-based and problem-focused experiences, and intellectual engagement in global contexts. Our academic and professional requirements maximize the disciplinary depth, transdisciplinary capabilities, inclusive perspectives, and purpose-driven engagement that are the hallmarks of the VT-Shaped student experience.

Admissions

The freshman and transfer applications to Virginia Tech automatically include consideration for admission to the Honors College and consideration for any relevant Honors College recruitment scholarships. The Honors College does not consider minimum test scores. We look holistically at an applicant's experiences and consider the quality of engagement over sheer quantity, self-awareness and reflection on involvement, and authenticity. Transfer students must have a cumulative GPA of 3.60 or better at their previous institution. Currently enrolled Virginia Tech may apply to the Honors College at the end of each fall or spring semester provided they have achieved a 3.60 or better cumulative GPA and have at least four (4) semesters remaining at Virginia Tech before they graduate.

Honors Laureate Diploma

Virginia Tech Honors College students work toward an Honors Laureate Diploma. This diploma offers two options: the first is self-directed by the student, the second maintains that flexibility, but focuses the honors credit options around a particular curricular area established in advance by the Honors College in collaboration with disciplinary departments.

The Four Elements of an Honors Education are the foundation of an Honors Laureate Diploma. The Elements are 1) Honors College Curriculum, 2) Disciplinary Depth, 3) Transdisciplinary Capabilities, and 4) Undergraduate Research & Guided Experiential Learning. Students are required to earn at least six honors credits in elements two, three, and four. Upon graduation, students are required to complete no less than thirty total honors credits. Visit our website at http://www.honorscollege.vt.edu for more information.

An honors diploma appears on the Virginia Tech diploma as a special designation and is not a separate document.

Honors Academic Requirements

The Course of Study Planner & GPA

- The Course of Study Planner (COSP)
  Students are strongly encouraged to complete a Course of Study Planner (COSP) in order to demonstrate their potential to earn an Honors Laureate Diploma.
- GPA
  To demonstrate that students can meet the level of academic achievement we expect in Honors, students are required to achieve a 3.60 or better cumulative GPA after two traditional semesters in Honors. A 3.6 or better cumulative GPA from the semester at Virginia Tech immediately previous to entering the Honors College may count toward this requirement.
- GPA Flex Period
  Once students accomplish the above goals, they may enter the GPA Flex Period. The GPA Flex Period is a time in which the Honors College no longer monitors GPA. This gives students the freedom to take academic risks that can become some of their most educational experiences.
- Graduation Requirement
  Students in the GPA Flex Period must achieve a cumulative 3.30 or better GPA and complete honors diploma requirements. (Students who never receive COSP approval and never enter the GPA Flex Period are required to maintain a 3.60 cumulative GPA after every semester until the planner is approved or upon graduation.)

Honors Diploma Progress

Complete at least thirty honors credits. Elements Two, Three, and Four each require at least six honors credits. Earn honors credit at least once every twelve months.

Grading Scale

Take courses as A–F unless P/F is the only option.

Honors Advising

A primary function of the Honors College is to support student efforts to individualize their education through a self-designed honors diploma that complements their departmental degree(s). Students can find support in the Honors Peer Advising Center and with the honors staff.

The Honors Peer Advising Center enables honors students to meet individually with trained Honors Peer Advisors to talk through processes and resources to solve Honors-related problems. The Honors Peer Advising Center also offers small-group workshops on topics of broad interest to honors students.

The Honors Peer Advising Center enables honors students to meet individually with trained Honors Peer Advisors to talk through processes and resources to solve Honors-related problems. The Honors Peer Advising Center also offers small-group workshops on topics of broad interest to honors students.

The honors staff also welcomes student appointments and walk-in visits. Each staff member has a distinct specialization with which they can assist students.

Furthermore, advising for major national and international scholarships, such as Rhodes and Marshall, is available through the Honors College for all Virginia Tech students.

Honors Living-Learning Programs

Honors College students have two Honors community options: the Hillcrest Honors living–learning community houses about 100 students in Hillcrest Hall and the Honors Residential Commons houses about 320 students in East Ambler Johnston Hall. Both communities are multigenerational and multidisciplinary, housing first-year students to fifth-year seniors from all seven colleges at Virginia Tech.

Honors students are not required to live in an Honors living–learning program. Many students live off-campus or in other living-learning programs.

Undergraduate Course Descriptions (UH)

1504: PGS PSTUDY ABROAD PRE-DEPARTURE SEMINAR
Orientation for Presidential Global Scholars (PGS) participants. Introduction to theories of culture and cross-cultural competence. Survey of Swiss culture, history, and politics. Introduction to PGS faculty and research interests. Development of individual research questions; transdisciplinary research on critical issues in U.S. contexts. Critical travel and safety information. (2H,2C)

1604: HONORS UNDERGRADUATE RESEARCH PRACTICES
Best practices in undergraduate research for Honors College students, including generating introductory research questions, finding scholarly literature, organizing data, research ethics, collaborative research practices, reflective project management and problem-solving, and oral, written, and visual presentation of research findings. (3H,3C)

1984: SPECIAL STUDY
Variable credit course.

2124: HONORS READING SEMINAR
Reading based sections in which small groups of students practice discussion, debate, and argumentation grounded in a topic or genre of reading of their group's choosing. Honors standing. Variable course content. Repeatable for up to six credits. Pass/Fail only. (1H,1C)

2504: TOPICS IN DISCOURSE AND GLOBAL CITIZENSHIP
Discovery, analysis, creation, and evaluation of written, spoken, and visual presentation of ideas in cross-cultural contexts. Special attention to the relationship of rhetoric to effective participation in academic, professional, and public/civic problem-solving. Course cannot be repeated for credit. Co: 2524, 2534, 4994, 2554, 2544. (3H,3C)

2524: TOPICS IN NATURAL SCIENCES AND GLOBAL CITIZENSHIP
Study of a specific branch of the natural sciences, especially as it intersects with public/civic controversies and problem-solving. Cross-cultural perspectives on the nature, purposes, and processes of scientific inquiry and knowledge. Course cannot be repeated for credit. Co: 2504, 2534, 4994, 2554, 2544. (3H,3C)

2534: TOPICS IN DESIGN, ARTS, AND GLOBAL CITIZENSHIP
Study and practice in the process, meaning, and value of creative design and the fine and performing arts. Examination of historical context and methods of representation in artifacts and performances. Visual literacy and design thinking as means of exploring, engaging with, and representing cross-cultural experiences and perspectives. Functions of design thinking in everyday life. Course cannot be repeated for credit. Co: 2504, 2524, 4994, 2554, 2544. (3H,3C)

2544: TOPICS IN SOCIAL SCIENCE AND GLOBAL CITIZENSHIP
Study of the behavior and actions of individuals, groups, and institutions within larger social, economic, political, and geographic contexts, especially in cross-cultural settings. Special attention to social beliefs and actions as they influence public/civic controversies and problem- solving. Examination of the influence of value and beliefs on human behavior and social relationships. Course cannot be repeated for credit. Co: 2504, 2524, 4994, 2554, 2534. (3H,3C)

2554: TOPICS IN HUMANITIES AND GLOBAL CITIZENSHIP

Analysis and interpretation of texts and other artifacts to understand ideas, values, and identities in cross-cultural contexts. Special attention to the functions of narrative and rhetoric in public/civic controversies and problem- solving. Situating local/regional texts and artifacts in global frameworks. Course cannot be repeated for credit. Co: 2504, 2524, 4994, 2544, 2534. (3H,3C)

2604: INTRODUCTION TO HONORS TRANSDISCIPLINARY RESEARCH
Introduction to transdisciplinary research (TDR) for Honors College students, including the differences among disciplinary, interdisciplinary, multidisciplinary, and transdisciplinary research; need and benefits of TDR; major figures and events in the history of TDR; characteristics of TDR design; ideal TDR processes and their management; challenges of TDR; opportunities for TDR in the students' majors and professions. Students must complete at least 6 credits of study within their major prior to enrollment in UH 2604. (3H,3C)

2744: FOUNDATIONAL TOPICS IN COMPUTING IN TECHNOLOGY INNOVATION FOR SOCIETAL IMPA
Foundational study of applications of computational thinking in technology innovation for societal impact. Key components of computing and their interrelation. Uses of computational thinking to frame questions and devise solutions. Implementation of simple computational processes and tools. Construction of computational models to analyze and draw inferences about complex and uncertain phenomena. Evaluation of knowledge based on quantitative data. Impacts of computing and information technology on society. Ethical dimensions of computing for technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits. Pre: MATH 1014. (1H,1C)

2754: ADVANCED TOPICS IN COMPUTING IN TECHNOLOGY INNOVATION FOR SOCIETAL IMPACT
Advanced study of applications of computational thinking in technology innovation for societal impact. Uses of computational thinking to frame questions and devise solutions. Application of computational processes and tools. Application and evaluation of computational models to analyze and draw inferences about dynamic and uncertain phenomena. Impacts of computing and information technology on society. Ethical dimensions of computing for technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits. Pre: MATH 1225 or MATH 1524 or MATH 1535. (1H,1C)

2764: ADVANCED TOPICS IN ENGINEERING IN TECHNOLOGY INNOVATION FOR SOCIETAL IMPACT
Study of applications of computer and systems engineering in technology innovation for societal impact. Application of computer and systems engineering processes and tools to analyze complex or large-scale phenomena. Application and evaluation of computer and systems engineering approaches to analyze and draw inferences about the feasibility and effectiveness of technological innovations. Impacts of computer and systems engineering on society and the environment. Ethical dimensions of computer and systems engineering for technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits. Pre: 2744. (1H,1C)

2814: TOPICS IN SOCIAL SCIENCES FOR TECHNOLOGY INNOVATION FOR SOCIETAL IMPACT
Threshold concepts in social sciences related to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas about the behavior of individuals, groups, and institutions related to technology innovation within larger social, economic, political, and geographic contexts. Use of key concepts in the social sciences to examine the ethical dimensions of technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits. (1H,1C)

2824: TOPICS IN THE ARTS FOR TECHNOLOGY INNOVATION FOR SOCIETAL IMPACT
Application of threshold concepts in the fine arts to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas for non-specialists about the formal elements, process, meaning, and value of the fine arts in technology innovation. Use of key concepts in the fine arts to examine the ethical dimensions of technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits. (1H,1C)

2834: TOPICS IN HUMANITIES FOR TECHNOLOGY INNOVATION FOR SOCIETAL IMPACT
Threshold concepts in the humanities related to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas and values related to technology innovation in various spatial, cultural, and temporal contexts. Use of key concepts in the humanities such as historical/cultural context and the nature of the good to examine the ethics of technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits. (1H,1C)

2855-2856: CALHOUN TRANSDISCIPLINARY FUSION STUDIO
Introduction to transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 2855: Collaborative problem-setting. Evaluative criteria for technology innovation: feasibility (can it be made?), viability (is it financially sensible?), desirability (do people want it?), and sustainability (can it work long-term?). Introduction to design thinking. Ethical dimensions of collaborative technology innovation for societal impact. 2856: Collaborative problem-solving. Introduction to quantitative and qualitative research methods. Optimization and integration. Design thinking and component prototyping. Ethical dimensions of collaborative technology innovation for societal impact. Design Lab/Studio. (2H,2L,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3204: HONORS SERVICE LEARNING
A two-part course. Part one: three hours a week working directly with community partners. Part two: a one-hour class to reflect on the service experience and discuss readings and other course materials that place the experiential learning into a theoretical context. Open to all Honors students. Variable course content. Repeatable for up to six credits. (1H,6L,3C)

3855-3856: CALHOUN TRANSDISCIPLINARY DESIGN STUDIO
Intermediate study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 3855: Systems thinking and systems definition; identification and analysis of stakeholders; skills discovery and transdisciplinary team building; rapid prototyping. 3856: Collaborative innovation; customer discovery; evidence-based decision-making; iterative design; troubleshooting. Design Lab/Studio. Pre: 2856 for 3855; 3855 for 3856. (2H,2L,3C)

3954: STUDY ABROAD
Honors Section. Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4004: HONORS TUTORIAL
Small, seminar-style course of one or a few students. Students explore a specific topic that is new to them with a faculty member who provides individual attention and is an expert in that established field. Open to all Honors students. Junior Honors standing. Variable course content. Repeatable for up to six credits. (1H,6L,3C)

4104: HONORS STUDENT TEACH PRACTICUM
For Honors students facilitating Honors courses that encourage and require student facilitation or mentorship responsibilities. Student Teaching Assistants and their sections are overseen by honors faculty or staff. Student Teaching Assistants meet weekly with a member of the honors staff in a class designed to prepare them for the facilitation experience and to monitor their progress. Open to all Honors students, subject to Program approval. Sophomore Honors standing required. Variable course content. Repeatable for up to eight credits. P/F only. Pass/Fail only. (1H,2L,2C)

4504: TOPICS IN HONORS DISCOVERY AND INNOVATION STUDIOS
Discovery and definition of critical, real-world problems. Transdisciplinary collaboration, design thinking, and experimentation. Reflective evaluation of individual and collective problem-solving efforts. Communication of solutions to diverse stakeholders. Pre: Junior Honors. Variable course content. Repeatable for up to 12 credits. (3H,3C)

4855-4856: CALHOUN TRANSDISCIPLINARY CAPSTONE STUDIO
Advanced study of transdisciplinary, collaborative design processes to address real-world problems in

technology innovation provided by clients from business, government, and nonprofit organizations. 4855: Systems building; project leadership and management, including resource allocation and scheduling; team management; value propositions; project pitches. 4856: User experience; user testing; systems assessment, including feasibility, viability, desirability, sustainability, optimization, and integration; systems reflection and documentation. Design Lab/Studio. Pre: 3856 for 4855; 4855 for 4856. (2H,2L,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

University Academic Advising Center

Kimberly S. Smith, Ph.D., Assistant Provost for Academic Advising Initiatives
Assistant Directors of Academic Advising Initiatives: B. Blair, N. Schwab, and L. Thomas
Director: Zackary Underwood, Ph.D. **Associate Director:** Herbert Bruce, Ph.D.
Advisors: L. Bressin, J. Chatham, H. Goetz, J. Johnson, and D. Sano-Franchini

Phone: 540-231-8440

University Academic Advising Center

The University Academic Advising Center serves the university community in several ways. First, it administers the University Studies and Explore Technology programs for new undergraduate students who want to explore a variety of degree programs before they commit to one particular major. Students who enter Virginia Tech as University Studies or Explore Technology are not limited to pursuing a specific major in their first year. With the guidance of a professional academic advisor, students research the full range of degree programs related to their interests and design programs of study that meet graduation requirements while providing the academic flexibility to pursue whichever degree program they ultimately choose. Second, the Advising Center assists new students who intend to reapply to competitive admission majors. Advisors work with these students in developing programs of study that meet the established criteria for admission into their chosen major. For both of these student populations, the University Academic Advising Center serves as both the college and department, providing administrative services, dean's office services, and academic advising until the students enter a specific major.

University Studies

University Studies is a major but it is not a degree-granting program. University Studies offers a structured advising program that provides students with the necessary support and strategies to investigate and compare academic disciplines so that they can make informed decisions about the degree programs they will pursue. Students can explore any major available at the university while completing course requirements toward a baccalaureate degree. To ensure that students graduate in a timely manner, University Studies requires all students to enter a specific degree program by the time they have earned 60 credits toward graduation (approximately the end of the sophomore year) or have attempted 72 hours.

Explore Technology (XT)

XT is a major but it is not a degree granting program. XT allows students to explore majors that are related to technology and adds technological skills to other existing majors. All students in XT will take the Exploring Technology Pathways to Success course. This course will allow you to explore different majors that fit your skills and interests while preparing you for success at Virginia Tech. The course is part of the

First Year Experience program and, best of all, will be taught by your academic advisor. To ensure that students graduate in a timely manner, XT requires all students to enter a specific degree program by the time they have earned 60 credits toward graduation (approximately the end of the sophomore year) or have attempted 72 hours.

Restricted Majors

University Studies and Explore Technology students can pursue any major offered at the university; however, students should be aware that some majors are competitive for internal transfer. These programs have established specific criteria and application procedures that students must fulfill in order to be considered for internal transfer into the major. In general, these criteria require students to demonstrate proficiency in designated core courses and, for some programs, in introductory major courses before they are eligible to apply. University Studies and Explore Technology students enter and graduate from these restricted programs each year; however, since there is no guarantee of acceptance to these programs, students are encouraged to investigate alternative majors even as they prepare to enter a restricted program.

Restricted Programs for Internal Transfers

College of Agriculture and Life Sciences

- Human Nutrition, Foods and Exercise

College of Architecture and Urban Studies

- Architecture
- Art and Art History - Visual Communication (Graphic) Design; Studio Art
- Creative Technologies
- Industrial Design
- Interior Design
- Landscape Architecture
- Minor: Industrial Design

Pamplin College of Business

- Accounting and Information Systems
- Business Information Technology
- Finance, Ins. & Business Law
- Hospitality and Tourism Management
- Management
- Marketing
- Minor: Business

College of Engineering

- All majors

Academic advisors in the University Academic Advising Center are familiar with the internal transfer criteria and procedures for all restricted programs and will assist students in fulfilling these requirements.

Pathways to General Education

All undergraduate students at the university, regardless of their majors, are required to fulfill general education course requirements in English, mathematics, science, social science, humanities, etc. There is a standard set of these courses, Pathways to General Education, which all degree programs incorporate in their graduation requirements.

In general, General Education requirements are completed in the freshman and sophomore years. Some majors are flexible with regard to which General Education courses can be used to fulfill degree

requirements; other majors designate specific General Education course selections. Academic advisors assist University Studies and Explore Technology students in selecting courses that apply towards as many of the majors a student is considering as possible. Thus, students fulfill degree requirements for graduation while they are exploring majors and are usually able to graduate on time.

Typical First Year Program	
First Semester	**Second Semester**
First-Year Writing	First-Year Writing
Mathematics	Mathematics
Natural Science (lab-if required by intended major)	Natural Science (lab-if required by intended major)
Social Science	Social Science
Humanities/Elective	Humanities/Elective/Major Specific Course

For University Studies and Explore Technology students, as for most students at the university, the first year is primarily devoted to fulfilling Pathways to General Education requirements. Of course, University Studies and Explore Technology students' programs of study vary depending upon the major or majors they are considering. Specific course selections are determined in individual consultation with an academic advisor.

Graduation Requirements

The requirements to graduate in a specific major are determined by the department and college conferring the degree. In general, students are required to have a minimum 2.0 overall grade-point average and a minimum 2.0 grade-point average in their major in order to graduate. The number of credit hours required for a baccalaureate degree varies from 120 to 136 hours, depending upon a student's major and degree program.

Honors College

The freshman application to Virginia Tech automatically includes consideration for admission to the Honors College and consideration for any relevant Honors College recruitment scholarships.

The Honors College does not consider minimum test scores. They look holistically at an applicant's experiences and consider the quality of engagement over sheer quantity, se;f-awareness and reflection on involvement, and authenticity.

A student's application to Virginia Tech automatically serves as an application to the Honors College. There is no separate deadline to be considered for the Honors College.

Dean's List

University Academic Advising Center students who demonstrate academic excellence are named to the Academic Dean's List and are awarded a Dean's List certificate. Students must be enrolled in a minimum of 12 graded hours (A-F) and must achieve a 3.4 GPA or higher in the fall or spring term to qualify.

Pre-Professional Advising

Students who want to enter professional schools but who have not yet chosen an undergraduate major will find that the university offers a variety of degree programs that provide excellent preparation for advanced training in professional fields. Though some professional programs, such as medicine, dentistry,

and veterinary medicine, require students to complete a minimum number of credit hours at the undergraduate level in chemistry, biology, mathematics, etc., professional schools do not dictate that students pursue specific undergraduate majors. A student can pursue almost any undergraduate degree and be competitive for admission to a professional program.

Global Education Office (Study Abroad)

Opportunities to study at institutions in other countries are available to all qualified students, regardless of their major. Study abroad offers students a unique opportunity to learn about other cultures and peoples while earning college credit. Students who intend to participate in an overseas study experience should discuss their intentions with their advisor early in their academic career.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Publication Information

Publication and Contractual Information

The provisions of this catalog do not constitute a contract, expressed or implied, between any applicant or student and Virginia Polytechnic Institute and State University. The university reserves the right to change any of the provisions, schedules, programs, courses, rules, regulations, or fees whenever university authorities deem it expedient to do so.

Virginia Tech does not discriminate against employees, students, or applicants on the basis of age, color, disability, gender, gender identity, gender expression, national origin, political affiliation, race, religion, sexual orientation, genetic information, or veteran status; or otherwise discriminate against employees or applicants who inquire about, discuss, or disclose their compensation or the compensation of other employees, or applicants; or any other basis protected by law. Discrimination or harassment on any of these bases is prohibited by **Policy 1025**, "Anti-Discrimination and Harassment Prevention Policy."The university is subject to Titles VI and VII of the Civil Rights Act of 1964; Title IX of the Education Amendments of 1972; Sections 503 and 504 of the Rehabilitation Act of 1973; the Americans with Disabilities Act of 1990, as amended; the Age Discrimination in Employment Act; the Equal Pay Act; the Vietnam Era Veterans' Readjustment Assistance Act of 1974; Federal Executive Order 11246; Genetic Information Nondiscrimination Act of 2008 (GINA); Virginia's State Executive Order Number Two; and all other applicable rules and regulations.

Information about **campus and workplace violence prevention** is available online. Individuals with questions or concerns about Policy 1025, any of these regulations, or related issues should contact:

Frank Shushok
Senior Associate Vice President for Student Affairs
Interim Title IX Coordinator
Office of Student Programs
New Hall West - Suite 160
190 West Campus Drive
Blacksburg, VA 24061
Email: fshushok@vt.edu
Phone: (540) 231-8064

Policy Statement on Sexual Harassment

Sexual harassment is a form of discrimination based on sex and falls within the statutory prohibitions against sex discrimination. The university is committed to maintaining a working and a study environment free of sexual harassment. Accordingly, in compliance with Section 703 of Title VII of the Civil Rights Act of 1964 and Title IX of the Education Amendments of 1972, it is the university's policy not to tolerate any verbal, nonverbal, or physical behavior which constitutes sexual harassment (please see **University Policy 1025**; the University's policy on harassment, discrimination, and sexual assault). Responsible employees are required to report their knowledge of sexual harassment to the University's Title IX Coordinator. Personnel with supervisory responsibilities are required to take immediate and appropriate action when incidents of alleged sexual harassment are brought to their attention and should do so in consultation with the University's Title IX Coordinator. Violations of the policy prohibiting sexual harassment may lead to disciplinary actions, including reprimand, suspension, or termination of employment or academic status.

Sexual harassment is defined as conduct of any type that is based upon a person's sex (including pregnancy), and unreasonably interferes with the person's work or academic performance or limits participation in university activities, or creates a working or learning environment that a reasonable person would find hostile, threatening or intimidating. Sexual harassment includes sexual advances, requests for sexual favors, sexual jokes, and unwelcome sexual touching, among other things.

Faculty, staff, students, and applicants for employment or admission with complaints of sexual harassment should contact the Office for Equity and Accessibility for resolution options. Individuals may file a complaint of harassment and/or discrimination by returning a complaint form.

Faculty, staff, and students may file complaints outside the university. Students may file complaints with the Office of Civil Rights of the Department of Education. Faculty and staff may file complaints with the Equal Employment Opportunity Commission.

Anyone seeking guidance, resources for support, or general information may contact the Office for Equity and Accessibility at **equityandaccess@vt.edu**. The Title IX Coordinator, Dr. Kelly Oaks may be reached at 540-231-2010.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Agriculture & Life Sciences

Course Descriptions & Programs of Study

Dean: Alan Grant
Associate Dean & Director of Academic Programs: Susan S. Sumner

Associate Dean & Director of Virginia Agricultural Experiment Station: Saied Mostaghimi
Associate Dean & Director of Virginia Cooperative Extension: Ed Jones
Associate Dean & Director of Global Programs: Thomas L. Thompson

Web: **www.cals.vt.edu**

Mission

The college creates, integrates, and shares knowledge to enhance:

- Life sciences, food, and agricultural systems
- The economic prosperity and life quality of the greater community
- The stewardship and health of land, water, and air for future generations
- Student learning through diverse, hands-on, experiential opportunities

Vision

We address current and emerging issues in agricultural and life sciences by building on the land-grant commitment of developing leaders and creating and sharing knowledge through diverse, hands-on applications.

Values

The College of Agriculture and Life Sciences embraces the following core values:

- A commitment to inclusive and diverse communities
- Freedom of inquiry
- Mutual respect
- Lifelong learning
- *Ut Prosim* (That I May Serve)
- Personal and institutional integrity
- A culture of continuous improvement
- Integrated scholarship across the land-grant missions

- International engagement
- Interdisciplinary collaboration

Undergraduate Programs

The undergraduate program in the college is organized into majors designed for students with widely different interests. These majors permit the student to achieve a satisfactory degree of specialization while providing the fundamentals necessary for continuing professional growth after graduation.

Freshman students may enter the college with the designation LFSC (Exploring Life Sciences). Upon completion of the freshman year, a college major should be selected.

Students who plan to transfer to Virginia Tech and major in the College of Agriculture and Life Sciences after two years of community college enrollment are encouraged to complete as many of the Pathways curriculum courses as possible before they transfer.

Undergraduate Majors Offered:

- Agribusiness
- Agricultural Sciences
- Agricultural Technology (associate degree)
- Animal and Poultry Sciences
- Applied Economic Management
- Biochemistry
- Crop and Soil Environmental Sciences
- Dairy Science
- Environmental Horticulture
- Environmental Science
- Food Science and Technology
- Human Nutrition, Foods and Exercise
- Landscape Horticulture and Design

Minors Offered:

- Agribusiness Management
- Agricultural and Applied Economics
- Animal and Poultry Sciences
- Civic Agriculture and Food Systems
- Crop and Soil Environmental Sciences
- Dairy Science
- Entomology
- Environmental Economics, Management and Policy
- Environmental Science
- Equine Science
- Food Science and Technology
- Global Food Security and Health
- Horticulture
- Integrative Health and Wellness
- International Agricultural and Life Sciences
- International Trade and Development
- Leadership and Social Change
- Plant Health Sciences
- Turfgrass Management

- Viticulture
- Wetland Science

College-wide Minors

The college offers four transdisciplinary and experiential-based minors: Civic Agriculture and Food Systems (CAFS), International Agricultural and Life Sciences (IAG), Integrative Health and Wellness (IHW), and Global Food Security and Health (GFSH). The CAFS and GFSH are Pathways minors. A cross-campus team of faculty, staff, students, and community partners collaborate to deliver these minors.

Living-Learning Community (LLC) and Residential College (IRC)

Meraki LLC

Students will be encouraged to put their passion, creativity, and soul into finding themselves through well-being.

ORION LLC

As a community of curious thinkers, we pursue science to serve humanity and the earth that we inhabit.

Leadership and Social Change RC

The mission of the Leadership and Social Change Residential College is to offer students a theoretical foundation combined with the practical knowledge and skills necessary to lead in a complex global environment.

Experiential Learning

Students are encouraged to participate in internship and co-op opportunities to gain relevant work experience prior to graduation. Departmental career advisors can help students identify opportunities. In some cases, students can receive credit for qualifying work experience. Enrichment studies include research field study opportunities, study abroad and summer laboratory experiences outside the university.

Research opportunities and experiencing the excitement of discovery can play an important part in undergraduate training in science. College of Agriculture and Life Sciences departments offer diverse research opportunities in which students may choose to participate. Individuals interested in undergraduate research should contact faculty members in the departments where they wish to conduct research.

The Academic Programs Office in the college, in cooperation with the Global Education Office, offers several avenues for students both in and outside the college to gain international knowledge and experience. These study opportunities allow students and faculty to become aware of and develop basic knowledge of food, fiber, and environmental issues in the world. Specific activities include study abroad programs and courses, international internships, formal student exchange programs, seminars and workshops on campus, and courses in the college, which focus on international topics. All of the departments in the college offer education abroad opportunities and students wishing to explore these opportunities should contact their advisor.

Advising

Students are assigned an advisor for their major during their first semester of enrollment at Virginia Tech. In order to put together a solid plan to finish a degree, advising is critical. Advisors in the College of Agriculture and Life Sciences are among the best resources on campus. In fact, they consistently win awards for the quality of advising they provide. Virginia Tech is a big university, but advisors make it seem like a small town where everyone knows everyone else.

Each year over 50% of our graduating students are admitted to a professional school. Pre-health advising (e.g. pre-dentistry, pre-medicine, and pre-veterinary) is coordinated through the Office of Health Professions located in Career and Professional Development.

Career advising is available from a number of sources. The university offers centralized career services and on-campus interviewing. The College of Agriculture and Life Sciences works with employers interested in hiring students with degrees from the college and organizes employer panels and information sessions. The university office of Career and Professional Development offers several job/career fairs throughout the year, which gives students the opportunity to connect with potential employers.

Career and Professional Development also offers each student access to a computerized program to connect students with potential employers. Undergraduate students who are seeking any type of career-related employment, including internships, co-ops, career-related summer employment, and permanent positions are eligible to use this system.

Scholarships

College and departmental scholarships are available for students enrolled in the College of Agriculture and Life Sciences. Applications are accepted through the University's Scholarship Central. Descriptions and deadlines are available on the Scholarships and Financial Aid website at **www.finaid.vt.edu**.

Honor Societies

Gamma Sigma Delta - Gamma Sigma Delta is an organization having as its objectives the advancement of agriculture in all its phases, the maintenance and improvement of the relations of agriculture and related sciences to other industries, and the recognition of the responsibilities of those engaged in all aspects of agriculture to humankind. Our Society seeks to encourage high standards of scholarship and worthy achievements in all branches of the agricultural and related sciences as well as a high degree of excellence in the practice of agricultural pursuits.

Phi Kappa Phi - Phi Kappa Phi has chapters on nearly 300 select college and university campuses in North America and the Philippines. Membership is by invitation only to the top 10 percent of seniors and graduate students and 7.5 percent of juniors. Faculty, professional staff, and alumni who have achieved scholarly distinction also qualify. The Society's mission is "To recognize and promote academic excellence in all fields of higher education and to engage the community of scholars in service to others."

Phi Beta Kappa - Phi Beta Kappa is the oldest and most prestigious honor society dedicated to recognizing excellence in the liberal arts and sciences. Students in the College of Agriculture and Life Sciences who have exhibited outstanding academic ability in eligible coursework may be eligible for selection to Phi Beta Kappa.

Graduate Programs

All College of Agriculture and Life Sciences departments offer graduate degrees at both the Master's and Ph.D. levels. Complete information on these programs including descriptions of graduate courses can be found in the **Graduate Catalog**.

Undergraduate Course Descriptions (ALS)

1004: AGRICULTURE, THE ARTS AND SOCIETY
Introduction to the relationships among agriculture, society, and the arts, all of which are integral components of civilization. Pass/Fail only. (1H,1C)

1234: CALS FIRST YEAR SEMINAR
Exploration of topics related to the College of Agriculture and Life Sciences (CALS) from a multidisciplinary perspective with a focus on communication and teamwork, problem-solving, inquiry, and integration. Students explore resources to promote academic success, investigate careers and academic areas, and develop a

comprehensive plan of study. Freshman and transfer students only. (1H,1C)

1984: SPECIAL STUDY
Variable credit course.

2204: INTRODUCTION TO CIVIC AGRICULTURE
Introduction to the economic, social, and ecological foundations of civic agriculture. Topics include industrialization, localized food systems, and citizen participation in civic agriculture. Emphasis will be given to a range of civic agriculture models, strategies, and hands-on approaches to establish, retain and strengthen community-based food and agriculture systems, locally- nationally-globally. (3H,3C)

2304: COMPARATIVE ANIMAL PHYSIOLOGY AND ANATOMY
Comparative anatomy and physiology of domestic mammals and birds including cell neural, musculoskeletal, respiratory, cardiovascular, urinary, and endocrine systems. Pre: BIOL 1106. (3H,2L,4C)

2404 (BIOL 2404): BIOTECHNOLOGY IN A GLOBAL SOCIETY
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening. Pre: (BIOL 1015, BIOL 1016) or (BIOL 1105, BIOL 1106) or (BIOL 1205H, BIOL 1206H), (C HEM 1015, CHEM 1016). (3H,3C)

2504: ANIMALS IN SOCIETY
Overview of animal well-being and behavior, human-animal interactions, responsibilities to animals, animal care, behavior, disease and pain recognition and current topics concerning companion animals, domestic animals and wildlife. (2H,3L,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2984L: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3104: ANIMAL BREEDING AND GENETICS
Principles of genetics related to improvement of domestic farm animals. Molecular, cellular and physiological genetics, estimation of breeding values, selection, heritabilities, genetic correlations, relationships, in-breeding, heterosis, genetic abnormalities. Pre: BIOL 1105, STAT 2004. (2H,2L,3C)

3204: ANIMAL NUTRITION AND FEEDING
Characteristics, sources, digestion, absorption, and metabolism of water, carbohydrates, lipids, proteins, vitamins, and minerals. Feeding systems for livestock, poultry and companion animals. Pre: 2304, (CHEM 1036 or CHEM 1036H or CHEM 1016). (3H,3C)

3304: PHYSIOLOGY OF REPRODUCTION
Physiological mechanisms that control and affect reproductive processes in domestic species. Investigation of the anatomy and physiology of the reproductive systems from cellular to whole-body levels with a particular emphasis on implications for reproductive function. Pre: 2304. (3H,3C)

3314: PHYSIOLOGY OF REPRODUCTION LAB

Investigation of the structure and function of reproductive systems of domestic species. Practical application of this knowledge is then taught through demonstrations, hands-on experiences and assignments exploring current farm-animal production systems. Co: 3304. (3L,1C)

3404: ECOLOGICAL AGRICULTURE: THEORY AND PRACTICE
Presents an overview of historic and modern agricultural practices. Surveys the principles of ecology in the context of managed ecosystems, civic agriculture, and food systems. Explores ecologically based practices and their use in holistic and integrated agricultural systems. (2H,3L,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4204: CONCEPTS IN COMMUNITY FOOD SYSTEMS
Examination of the economic, political, socio-cultural, health and environmental issues related to community food systems and agricultural practices. Topics include local, regional and global food systems development, food production and biotechnology, food sovereignty and security, and population and environmental health. Analyze models, strategies, and policies within local, national and global food systems. Pre: 3404. (3H,3C)

4214: CAPSTONE: CIVIC AGRICULTURE AND FOOD SYSTEMS
Multidisciplinary, experiential community-based course focusing on civic agriculture-food systems. Work in partnership with community stakeholders to propose viable solutions to real world issues revolving around civic agriculture and food systems. Connect with communities locally, regionally or globally. Pre: 2204, 3404, 4204. (3H,3C)

4244: GLOBAL FOOD SECURITY AND HEALTH CAPSTONE EXPERIENCE
Food security and its relationship to human and global health challenges. Role of geography, economics, climate, politics, trade, and culture. Ethical issues and challenges to improving global food security and health. Creatively analyze, synthesize, and evaluate learned knowledge. Participate in successful discourse related to global food security and health. Pre: CSES 2244, AAEC 3204. (3H,3C)

4554 (BIOL 4554): NEUROCHEMICAL REGULATION
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet. Pre: (2304 or BIOL 3404), CHEM 2535. (3H,3C)

4574 (BIOL 4574): SOCIAL BEHAVIOR OF BIRDS AND MAMMALS
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural, companion and laboratory settings are discussed. Pre: 3104 or BIOL 2004, BIOL 1106. (3H,3C)

4614 (WATR 4614): WATERSHED ASSESSMENT, MANAGEMENT, AND POLICY
Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, FREC, GEOL, LAR, CSES, ENT, BIOL, GEOG, AAEC, UAP or equivalent. (2H,2C)

4714 (HORT 4714): GLOBAL SEMINAR
Student-centered internet-based course including text and real-time video conferencing among students at collaborating institutions in the United States and Canada. Focus is contemporary North American environmental sustainability issues based on student-prepared case studies. Pre-requisite: Junior or Senior

Standing required. (1H,1C)

4964: FIELD STUDY/PRACTICUM
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Architecture & Urban Studies

Course Descriptions & Programs of Study

Dean: Richard J. Blythe
Associate Dean for Academic Affairs: Kathryn Clarke Albright
Associate Dean for Research: Robert P. Schubert
Associate Dean for Graduate Studies: Paul Emmons

Web: www.caus.vt.edu

Overview

The College of Architecture and Urban Studies is comprised of four schools. The School of Architecture + Design includes accredited undergraduate and graduate programs in architecture, landscape architecture, industrial design, and interior design. The School of Public and International Affairs includes undergraduate programs in smart and sustainable cities, and environmental policy and planning; graduate programs in public administration, public and international affairs and urban and regional planning; and doctoral programs in public administration and governance and globalization. The Myers-Lawson School of Construction, the first of its kind in the nation, brings together the Department of Building Construction in the College of Architecture and Urban Studies, and the Vecellio Construction Engineering and Management Program in the Via Department of Civil and Environmental Engineering, which includes graduate and undergraduate programs in building construction and in construction engineering and management. The college is also one of six colleges offering a program in Real Estate, an innovative interdisciplinary undergraduate degree program combining theory and industry practice. The School of Visual Arts offers undergraduate programs in art history, creative technologies, studio art, and visual communication design as well as a Master's of Fine Arts in creative technologies and a Master's in Material Culture and Public Humanities, jointly with the College of Liberal Arts and Human Sciences.

These programs share a common purpose—to understand and mold the built environment through acts of creation, design, construction, and analysis. These forces give meaning to the built environments that shape our lives.

Research and outreach programs supplement instructional efforts and are carried out through college centers and laboratories. Specialized research and outreach centers offer students and faculty members opportunities for concentrated investigations in such areas as history and theory of art and architecture, housing, metropolitan studies, community design, construction safety and health, high performance learning environments, community health, governance and accountability, public policy, women in architecture, environmental design and planning, design research, and visual design.

The college offers a range of advanced digital technologies including an array of rapid prototyping devices and a wide range of computing and graphic equipment in support of the instructional and research programs of the college. The Environmental Systems Laboratory (ESL) and the Research and Demonstration Facility (RDF) are available to faculty members and students for the conduct of research, in-depth investigations of environmental systems, prototype development, and industrial, graphic, and

product design. To support these endeavors, the college has the Virtual Environments Laboratory (VE Lab), Center for Advanced Visual Media, and the Visual Design Studio for Education, Research, Exhibition, and Outreach.

The Art and Architecture Library, a branch of the University Libraries, is located in Cowgill Hall and houses more than 60,000 volumes, 200 periodicals, and 65,000 architectural slides. The college also provides media facilities - VTR systems, photographic darkroom, printmaking, ceramics, and cinematographic space and equipment, 3-D printing, and plastics, wood and metal shops.

The college's Washington-Alexandria Architecture Center and Northern Virginia Center in Old Town Alexandria provide opportunities for architecture, landscape architecture, public administration, and urban and regional planning students to spend one or more semesters in the Washington, DC metropolitan area examining the range of design and planning problems found in large urban centers. In addition to classes, studios, and curricula at the undergraduate and graduate levels, the centers offer research and continuing education opportunities for students, faculty, and alumni, and facilitates participation in the rich educational and cultural opportunities of the greater Washington area.

The Europe Studio, based at the university's Steger Center for European Studies and Architecture in Riva San Vitale, Switzerland, provides undergraduate and graduate study opportunities for students college-wide. Studios, seminars, and organized travel are offered. The college also sponsors an array of additional study abroad opportunities, including study-travel programs elsewhere in the world.

Students who wish to combine degree options within the college or with related disciplines within the university should contact the major school or department regarding special undergraduate and graduate program requirements.

A Summer Qualifying Design Lab in the School of Architecture + Design is required for Virginia Tech students wishing to transfer into the college and change their major to the architecture, landscape architecture, industrial design, or interior design degree program.

Undergraduate Course Descriptions (CAUS)

1004: EXPLORING ARCHITECTURE & URBAN STUDIES
First-Year Experience course for Explore CAUS majors. Overview of the college and its degrees, majors and minors, and career opportunities available to CAUS graduates. Presents college and university resources and services that support student success. Introduces students to the basic principles of the research process by focusing on inquiry, problem-solving, and integration of ideas and experiences within the fields in the College of Architecture & Urban Studies. (2H,2C)

1984: SPECIAL STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Engineering

Course Descriptions & Programs of Study

Dean: Julia Ross
Associate Dean for Academic Affairs: Bevlee A. Watford
Associate Dean for Administration and Chief of Staff: Edward L. Nelson
Associate Dean for International Programs and Information Technology: Glenda R.

Scales
Associate Dean for Research and Graduate Studies: John J. Lesko

Web: **www.eng.vt.edu**

Mission of the College

Virginia Tech is the home of the commonwealth's leading College of Engineering. It is known in Virginia and throughout the nation for the excellence of its programs in engineering education, research, and public service. It is the state's largest engineering college and is the fifth largest producer of new B.S. degrees in the United States.

The mission of the College of Engineering is to offer high quality support for our stakeholders in order to provide a successful experience in the engineering education pursuits of our customers. The vision of the college is to foster strong working relationships between faculty, student, and industry partners that will ultimately bring research opportunities through engineering educational offerings. The goals of the college are to attract high-caliber students and to provide them with a top-quality engineering education in preparation for productive careers; to invest in faculty development to enhance Virginia Tech's reputation as a research university and a leader in graduate education; and to forge partnerships with industry and government to facilitate economic development within the Commonwealth and the nation; and to create transdisciplinary teams of students and faculty that will tackle the world's pressing problems through research, education, and engagement.

The College of Engineering offers bachelor of science degrees in the following areas: Aerospace Engineering, Biological Systems Engineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Computer Science, Construction Engineering and Management, Electrical Engineering, Engineering Science and Mechanics, Industrial and Systems Engineering, Materials Science and Engineering, Mechanical Engineering, Mining Engineering, and Ocean Engineering. The Biomedical Engineering program will seek accreditation following the awarding of the first bachelor of science degrees to graduates expected in 2022. The Computer Science program is accredited by the Computing Accreditation Commission of ABET. **www.abet.org** All other College of Engineering undergraduate programs in engineering are accredited by the Engineering Accreditation Commission of ABET. Additionally, the college of engineering offers graduate degrees related to each of these areas and in the interdisciplinary program of Systems Engineering.

Engineers play an important role in the world and are necessary to solve critical problems of the 21st century. They design and develop new and improved materials, products, and processes for households and industries, from tiny semiconductors, to huge dams, to ensure drinking water is safe. Engineers are needed across a broad spectrum of industry from the traditional fields such as mechanical to the emerging fields of blockchain and biomedicine. Engineers must not only satisfy society's demand for improved performance, reliability, and safety of products, they also are expected to create solutions for environmental and social problems created by emerging technologies.

Virginia Tech engineering graduates are problem solvers with learned classroom knowledge and hands-on applicable skills. Graduates with diverse perspectives trained in engineering will have numerous professional opportunities including large or small manufacturing industries, professional consultants. They may work in government or private research laboratories or teach and do research in universities. If the future leads them into other professions such as medicine, law, food services, or business, their engineering education will provide a sound base. Graduates are in high demand with the Wall Street Journal employer survey ranking the College of Engineering No. 5 in the nation. Our Student Engineers' Council's Engineering EXPO — Virginia Tech's largest career fair and one of the largest student-run career fairs in the nation — bring in well over 300 companies that includes: representatives from companies like NASA, Rolls-Royce, General Electric, Ford, Boeing, General Motors, Newport News Shipbuilding each year. The Virginia Tech College of Engineering is a key recruiting school for major national corporations and government agencies.

It is essential that engineers, regardless of specialty, be well-versed in mathematics, physical sciences and engineering sciences, so that they can adapt readily to meet the profession's ever-changing demands. But professional training is not enough.

Engineers need to have passion, imagination, and insight. They must understand history and traditions of the society in which they live and be familiar with social sciences and humanities. Engineers also must be able to communicate effectively with higher management and the general public. All departments within the college have programs to ensure that every graduate is able to effectively use a variety of spoken, visual, and written communication strategies, which are necessary for success as a student, for employment, and for life as a responsible citizen. Additionally, first year engineering classes emphasize the importance of communications in engineering analysis and design.

College Rankings

In U.S. News & World Report's "America's Best Colleges 2019" survey, released in September 2018, the College of Engineering's undergraduate program is ranked No. 13 among all undergraduate engineering programs that also offer doctoral degrees and eighth among public universities in the nation. Top 10 ranked departments include: the Grado Department of Industrial and Systems Engineering ranked, the Department of Biological Systems Engineering, and the Charles E. Via Jr. Department of Civil and Environmental Engineering.

The latest national survey, dated June 2017, released by the American Society for Engineering Education ranked the College of Engineering in the following categories: No. 6 for the number of women awarded bachelor's degrees, No. 6 for tenured/tenure track faculty members, No. 7 for the number of tenured/tenure track women faculty, No. 13 for the number of African American faculty, No. 10 for the number of Asian faculty, and No. 15 for the number of Hispanic faculty. The data was based on a survey of 315 engineering schools. For total bachelor's degrees awarded by schools, Virginia Tech ranked No. 5 in the nation; No. 41 for master's degrees awarded, and No. 9 for doctoral degrees. In total enrollment, the College ranked No. 9 in the nation for undergraduates with 8,151 students and No. 21 in the nation for graduate students at 2,274 (193 schools reporting).

Philanthropy Fuels Innovation

In May 2018, **Block.one**, a global leader in blockchain and publisher of the EOSIO blockchain software, made an initial $3 million commitment to the Department of Computer Science in Virginia Tech's College of Engineering to help students build skills in blockchain. As part of the collaboration, Dan Larimer, Block.one

chief technology officer and blockchain pioneer, will advise the university on curricula development, including participation in live classroom sessions, seminars, and symposia. Larimer is an alumnus of the Virginia Tech Department of Computer Science. Over the last year, the department hosted a blockchain bootcamp, first blockchain capstone course completed, and bloackchain challenge completed with prize money for top teams.

In Fall 2018, the Joseph "Joe" F. Ware, Jr. Advanced Engineering Lab celebrated 20 years of providing engineering students the opportunity to create, build, and bring to fruition their senior capstone projects. Thanks to the foresight and vision of Joe Ware and his wife Jenna, experiential learning is enhanced for the Virginia Tech undergraduate student engineer in this maker space. The lab removes boundaries that often separate engineering professions. In real-world practice, engineers from different disciplines will work together. Students who work in the lab are highly recruited by to top tier companies who frequent the lab looking for the well-rounded, globally minded engineers who have had hands on experiences. Many also complete their capstone course in this space, which are often topped off by participation in regional, national, or global competitions.

In November 2016, Virginia Tech named its Department of **Aerospace and Ocean Engineering** in honor of alumnus Kevin T. Crofton, president and chief executive officer of SPTS Technologies Ltd., in recognition of his extraordinary philanthropy. Crofton, a native of Fincastle, Virginia, committed $14 million to the department that bears his name, and $1 million to the university's **Division of Student Affairs**. The Kevin T. Crofton Department of Aerospace and Ocean Engineering has more than 550 undergraduate students and 160 graduate students enrolled. Its faculty and students are engaged in numerous areas of research, with annual expenditures of more than $8 million. Departmental facilities include wind tunnels, a flight-test runway and hangar, and an advanced power and propulsion laboratory.

In September 2016, Virginia Tech and **Qualcomm Inc.** began a multiyear collaboration with the launch of the Qualcomm Thinkabit Lab at Virginia Tech's Northern Virginia Center in Falls Church. The **Thinkabit Lab** experience offers both teachers and students an engaging learning environment — part lab, makerspace, and classroom — to foster creativity, collaboration, and the critical skills necessary for the 21st century. The new Thinkabit Lab is led by Virginia Tech's Department of Engineering Education in the **College of Engineering** based on Qualcomm's World of Work and STEM coursework. Residing in the Washington D.C area, the lab is Qualcomm's first outside of San Diego, servicing underserved students, students underrepresented in STEM careers, and teachers from the metro Washington, D.C. area. In two-and-a-half years, more than 17,000 visitors have walked through the doors of the lab.In addition, the bold program has touched more than 200,000 students, teachers, and administrators. In April 2019, a second Qualcomm Virginia Tech Thinkabit lab opened in Roanoke, Virginia. Numerous Thinkabit inspired maker spaces have opened in Virginia schools across the commonwealth.

Goodwin Hall houses scores of sensors that currently make it the most instrumented building in the world for vibrations. The roughly 153,000-gross square-foot facility serves as a leading center of engineering education in Virginia. Inside, a 15,000-pound Rolls-Royce Trent 1000 jet engine hangs 15 feet above the floor of the atrium. The engine acts as an art centerpiece of the structure, and as a learning tool for our students for years to come. Other highlights: A robotics lab with glass walls that allow visitors and passersby to see students at work, and a 3-D printer open to any student's use, and located in the atrium of the building. The building was named after alumnus Bill Goodwin and his wife, Alice, in fall 2014. The Goodwins donated $25 million to the construction of the building, a university record for a personal donation. Goodwin graduated with a bachelor's degree in 1962.

The College of Engineering-led Institute for Critical Technology and Applied Science is now housed in the **Hugh and Ethel Kelly Building** on campus. Ethel Kelly's estate provided $5 million to help cover the cost of the **most recent of three buildings built for the institute**. That building opened in 2011 and is on Washington Street. What is now **Kelly Hall** opened in 2009 and is on Stanger Street. Another $1 million from the estate supports the Hugh and Ethel Kelly Lecture Series. Hugh Kelly, who died in 1989, earned his bachelor's and master's degrees of electrical engineering in 1937 and in 1938, worked at AT&T's Bell Laboratories, and played important roles in groundbreaking projects, including the 1962 launch of the Telstar communications satellite, the first private venture in space. Ethel Kelly, who died in 2012, generously supported Virginia Tech's **College of Engineering** as a way of honoring her husband's legacy.

Virginia Tech College of Engineering and College of Science jointly house the **inVenTs Laboratory's Studio**

I, located on the second floor of Lee Hall. The inVenTs Residential Community provides an interdisciplinary living-learning space for students from engineering, science, and other disciplines to interact and together explore their ability to envision, create, and transform innovative ideas. Approximately 1,300 students have used the facility since its fall 2012 opening. The inVenTs community includes students from four university groups, the Curie Learning Community and the Da Vinci Biological and Life Sciences Community, both in the College of Science, and the Galileo and Hypatia learning communities within the College of Engineering. The retention rate for the students enrolled in the inVenTs program is almost 100 percent.

The Frith Freshman Design Laboratory is a space designed to support the retention and development of young engineers through hands-on learning, peer mentoring, and authentic problem-solving. Part collaboration and innovation space, part fabrication and prototyping space, and part learning laboratory, the Frith Lab enables first-year engineering students to learn by dissecting, designing, making, and analyzing engineering products. It features a tensile/compression materials testing machine, 3-D printers, laser engraver, CNC router, and drill press, along with various hand tools, housed in toolboxes available for checkout.

Green Engineering

Virginia Tech was one of the first universities to formally consider the connection between engineering practice and environmental stewardship from an interdisciplinary perspective. The Green Engineering Program was created in 1995 and serves all departments within the College of Engineering.

This program combines environmentally conscious attitudes, values and principles with science, technology, and engineering practice, and focuses this interdisciplinary approach toward improving local and global environmental quality. Based on engineering fundamentals, green engineering analyzes the design of products, processes, and systems to minimize the life cycle environmental impacts, from the initial extraction of raw materials to the energy consumption and waste production during manufacturing to the ultimate disposal of materials that cannot be reused or recycled.

The Green Engineering Program works with students, faculty and the university administration to provide educational and research opportunities with regard to both the environmental impacts and the environmental solutions that can result from engineering practice. A university-recognized minor allows students to pursue their interests in Green Engineering in addition to their primary degree(s) in the College of Engineering. To obtain this minor, students are required to take 18 credit hours in the minor area as follows: six (6) credits in the two core courses – Introduction to Green Engineering and Environmental Life Cycle Analysis; six (6) credits in interdisciplinary elective courses; and six (6) credits in disciplinary electives within the students' major. Detailed lists of the courses which meet the minor requirements can be found in the Green Engineering Web site: **www.eng.vt.edu/green**.

Impact

In 2018, Virginia Tech opened the country's tallest drone park--the latest superlative in a long tradition of autonomous systems research. The Virginia Tech Mid-Atlantic Aviation Partnership, which spearheaded the park's construction and runs its operations, also leads two major federal programs that further drone integration, with a portfolio of high-profile partners like Wing, State Farm, and NASA. The drone park helps extend Virginia Tech's national leadership in drone research, operations, and policy to an even broader group of students and faculty. Inside its boundaries, students, faculty, and staff can test prototype aircraft and run ambitious experiments that lie beyond the narrow, conservative scope of operations permitted in the open; novice pilots can practice their skills.

Since 2015, Marc Edwards, University Distinguished Professor of civil and environmental engineering, and his team of students and research scientists uncovered widespread lead-in-water contamination in Flint, Michigan. The team collected samples from locations across Flint and found extremely high levels of lead and other contaminants in the city's drinking water. In March 2016, the team of students returned to Flint on spring break, working alongside citizen volunteers in Flint collecting water samples for another round of lead testing. Results from the second round of testing showed Flint water is still not safe to drink, but should continue to be used, flushing lead from the system and allowing it to heal. Edwards, a leading expert in safe drinking water

and the deterioration of the water delivery infrastructure in America's largest cities, has worked to seek solutions to the crisis. He serves on Michigan Gov. Snyder's advisory group and has testified multiple times before Congress on the crisis. Edwards was named amongst TIME Magazine's 100 Most Influential people in the World, the World's 50 Greatest Leaders by Fortune Magazine, Politico Magazine's Top 50 Visionaries who have transformed American politics, Foreign Policy Magazines 100 World's Greatest Thinkers, and was short-listed amongst Flint whistleblowers as Time person of the year.

The College of Engineering provides experiential learning opportunities to include internships, co-ops and study. The college's **Rising Sophomore Abroad Program** offers concurrent tracks in the summer to locations on five continents. In six years, the program has grown from sending 24 students to nearly 180 students, making it the largest study abroad program at Virginia Tech. The program was recently awarded the Senator Paul Simon Spotlight Award by NAFSA: Association of International Educators.

Approved by the State Council of Higher Education for Virginia on Sept. 18, the degree will be offered through the **Department of Biomedical Engineering and Mechanics** within the **College of Engineering**, which currently hosts both master's and doctoral programs in biomedical engineering through a partnership with the **Wake Forest School of Medicine**. With the nation's demand for health-related services, products, and professionals expected to skyrocket over the next decade, students in the program will be uniquely trained to bridge the gap between traditional medicine and the technology needed to address emerging and complex health care problems. Accordingly, the new program will emphasize technology transfer, engineering fundamentals, and hands-on learning opportunities.

Through its University Technology Centers, Rolls-Royce has built a network for research and graduate education with 24 universities around the world. Building upon Virginia Tech's successful partnering on the Commonwealth Center for Aerospace Propulsions Systems and the Commonwealth Center for Advanced Manufacturing, Rolls-Royce awarded UTC standing for Virginia Tech and the University of Virginia.

With the release of **youth football helmet ratings** by the Virginia Tech Helmet Lab — already renowned for their helmet ratings for varsity football and other sports — consumers see for the first time which helmets best reduce concussion risk. The Virginia Tech Helmet Lab has been rating varsity football helmets since 2011; their five-star scale, which they have since expanded to other sports, has provided more clarity to consumers and helped drive innovation in the helmet industry. Other helmet, head gear or sensor ratings include: bicycle, soccer, softball, baseball, and hockey.

The college is known for its hands-on learning that takes place outside of the classroom. More than 50 current and former Virginia Tech students were involved in a different kind of auto competition called the Autodrive Challenge, which is not a race, but rather, a chance to prove that autonomous vehicles can safely and successfully navigate a course, so they can one day do the same on a city street. The students have different jobs in a competition that moves around the US over the course of four years. This team placed 2nd in the first year of the competition.

In November 2018, after years of research and development contributed by over 100 Virginia Tech students and faculty, the FutureHAUS Dubai team officially built the world's best solar home. The lone American team earned a first-place victory over 14 other selected teams and more than 60 total entrants of the 2018 Solar Decathlon Middle East, a competition launched by the **United States Department of Energy** and the United Arab Emirates' Dubai Electricity & Water Authority. The global competition aimed to accelerate research on building sustainable, grid-connected, solar homes. The concept of **FutureHAUS Dubai** was brought to life through a university-wide effort, combining talents and research from Virginia Tech's **College of Architecture and Urban Studies**, **College of Engineering**, **Myers-Lawson School of Construction**, **Pamplin College of Business**, **College of Liberal Arts and Human Sciences**, **College of Science**, and various centers and labs within.

Over the last several years, an interdisciplinary team of 50 undergraduate students from the College of Engineering and the College of Science developed Virginia Tech's CubeSat at the Center for Space Science and Engineering Research, known as Space@VT. The group of undergraduate students recently delivered their small satellite to Houston to be incorporated into NanoRacks' commercially developed CubeSat deployer. Virginia Tech's satellite, along with two satellites from other Virginia universities, launched on the payload section of Northrop Grumman's Antares rocket and then onto to the International Space Station.

Major Undergraduate Scholarships

In the 2018-2019 academic year, over three million dollars in scholarship funds were awarded to undergraduate students in the College of Engineering. Scholarships are available at two levels: departmental & college. While all scholarships are merit-based (all required a minimum 3.0 overall GPA to be awarded), may also require a demonstration of financial need per the FAFSA. More information about the types of scholarships awarded can be found at **https://eng.vt.edu/academics/undergraduate-students/scholarships-for-current-students.html**

Additional Facts about the College

The University Honors Program offers a unique challenge to students with extraordinary intellectual and creative abilities. The program is available to all engineering departments and includes the opportunity for enrollment in accelerated courses, enriched sections, and independent study.

A five-year Cooperative Education program for qualified students is available in all of the engineering curricula. After at least two qualifying semesters, students may alternate semesters of study on campus with work periods in industry. Participants are required to have a minimum of a 2.0 overall grade point average, and students must have earned a 2.0 in the semester prior to any work experience. Individual departments may impose higher GPA restrictions, including ones based on in-major GPA.

Nearly 10,000 students were enrolled in undergraduate and graduate engineering departments at Virginia Tech as of fall 2016. In the entering 2017-2018 freshman class, the average SAT score for the general engineering student was 1291 and the average high school grade point average was 4.14 on a weighted scale. Females made up 22% of the fall 2017 freshman class, and 22% of the total college population in fall 2017. Members of under-represented populations make up 30.1 percent of the freshmen class.

Of the 2016-2017 College of Engineering bachelor's degree graduates who were employed full-time, (the most recent year for which statistics are known), 67 percent were employed in a field related to their major and 13% were pursuing advanced degrees. The average annual salary at the bachelor's level was $65,000.

Admission

All students admitted to the College of Engineering as freshmen or external transfers are placed in the Department of Engineering Education and are designated as general engineering majors. Admission to a degree program is competitive, with departmental restrictions established each year by the college. Upon completion of a set of required freshman-level courses, and completion of 12 hours of A-F graded coursework at Virginia Tech, students with acceptable academic records are eligible for transfer into one of the college's 14 degree programs.

Students wishing to transfer into an engineering program or change majors from another college or degree program within the university must meet current standards set by the college for each engineering program. All major changes are processed by the Engineering Education department.

The college has a guaranteed admission agreement with the Virginia Community College System. VCCS students who complete the transferable Associate Degree in engineering with a minimum 3.2 overall grade-point-average are guaranteed admission to the College of Engineering as a General Engineering major. Not all Virginia Community Colleges offer engineering courses. The Associate Degree in engineering is offered at Blue Ridge, Central Virginia, Danville, Germanna, J. Sargeant Reynolds, John Tyler, Lord Fairfax, Mountain Empire, New River, Northern Virginia, Piedmont Virginia, Southwest Virginia, Thomas Nelson, Tidewater, Virginia Highlands, Virginia Western, Wytheville.

Engineering Technology credits are not accepted for transfer by the College of Engineering.

Out-of-state students in engineering come primarily from Maryland, New Jersey, Pennsylvania, and New York. Members of under represented populations (including women) make up 34% of the college enrollment.

In fall 2005, 4,800 prospective students applied for admission to the College of Engineering. By fall 2016, over 10,000 applied. Starting with fall 2010, the target size for the freshman engineering class was raised from 1200 to 1300, an 8 percent increase. In fall of 2015 the target was 1650, and some 1800 were admitted. In 2005 the entering engineering freshman class was 15.6 percent female, 2.1 percent African-American, 1.8 percent Hispanic. By comparison, in 2016 the entering engineering freshman class was 25.9 percent female. The number of entering females is a record.

Required Academic Progress

Minimum requirements for graduation include the attainment of at least a "C" (2.0 Grade Point Average) *average*, both overall and in-major. Some departments may have additional requirements or specifications concerning the acceptability of C- or lower grades for in-major courses. Students are expected to sustain progress towards completion of their degree requirements, consulting with their academic advisor regularly.

In addition to meeting university requirements, eligibility requirements for enrollment have been established by individual departments.

Entry into a degree-granting department requires that a student successfully complete all first year required courses, and at least 12 GPA hours at Virginia Tech. All degree-granting majors accept applicants on a space-available basis. The change of major requirements, policies, and dates can be located at: **www.enge.vt.edu/undergraduate-changing-majors.html**.

Graduation Requirements

Degree requirements in the college range from 123 to 132 semester hours. Students should see their departmental advisors to determine the exact requirements of their degree. The 2.0 minimum GPA requirement for graduation also applies to all courses attempted in the student's departmental major; substituted non-departmental courses are not included. Where courses have substantial duplication, credit toward graduation will be given for one course only.

The senior academic year must be completed in residence while enrolled in the major department in the College of Engineering.

Although pass/fail courses may be authorized for those who maintain a GPA above 2.0, students should recognize future disadvantages when transferring to other departments or applying for admission to other professional or graduate colleges. Engineering students are expected to take all major department courses on a grade basis. Independent study and undergraduate research courses are available for those who maintain a GPA above 2.0 overall and in their departmental majors; some departments may require a higher GPA.

The College of Engineering will accept advanced ROTC credit as free elective credit towards graduation. Some departments in engineering may allow the use of selected ROTC courses to meet technical elective requirements. Consult specific departments in the College of Engineering for information.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are outlined in university publications known as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **www.registrar.vt.edu/graduation/checksheets/index.html** for degree requirements.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Liberal Arts and Human Sciences

Course Descriptions & Programs of Study

Dean: Laura Belmonte
Associate Dean for Academic Policies and Procedures: Debra Stoudt
Associate Dean for Administration and Finance: Brian Shabanowitz
Associate Dean for Graduate Studies and Research: Thomas Ewing
Associate Dean for Undergraduate Academic Affairs: Daniel Thorp
Assistant Dean, Experiential Learning and Recruitment: Monica Kimbrell

Director of Academic Support: Karen Watson

Web: **www.liberalarts.vt.edu**

Overview

The College of Liberal Arts and Human Sciences offers baccalaureate degrees encompassing the humanities, performing arts, and human and social sciences. The College emphasizes the importance of mastering the intellectual skills a liberal arts education develops as well as job skills by encouraging students to apply knowledge from one field to another and to think creatively.

Outstanding faculty members conduct research and teach courses in 11 departments and 2 schools leading to baccalaureate and advanced degrees. Coursework from the College of Liberal Arts and Human Sciences also provides a foundation of knowledge in a number of fundamental subjects for students in all colleges through the General Education (Curriculum for Liberal Education/Pathways to General Education).

The college offers minors in many of the departments listed. Students are encouraged to include a minor in their program and should consult an advisor for help in choosing one that will advance their career goals.

General Requirements for Graduation

A student in the College of Liberal Arts and Human Sciences must complete at least 120 hours for an

undergraduate degree as well as satisfy the following requirements:

- achieve a minimum overall Grade Point Average (GPA) of 2.0 for all hours attempted (some majors may require a higher GPA)
- achieve a minimum overall GPA of 2.0 for all hours attempted in all work applied to the major (some majors may require a higher GPA)
- complete all other requirements established for their degree by the major department
- complete all college and university Curriculum for Liberal Education/Pathways to General Education requirements
- complete the language study requirement either through high school enrollment or prior to receipt of the undergraduate degree. The minimum requirement may be met in high school by completing 2 units of a single foreign or classical language or American Sign Language. Some majors in the College of Liberal Arts and Human Sciences may require 3 units of a single foreign or classical language or American Sign Language

No course required for graduation or in the major/minor may be taken on a pass/fail basis (i.e., pass/fail may be used for free electives only). This excludes courses that are offered pass/fail only.

General Education - Curriculum for Liberal Education (CLE)/Pathways to General Education

A description of the General Education - Curriculum for Liberal Education (CLE) and the new Pathways to General Education may be found in the **Academics** section of this catalog. For requirements specific to departments in the College of Liberal Arts and Human Sciences, please contact the individual department.

Honors College

The University Honors Program is available to students in the College of Liberal Arts and Human Sciences. This program provides an enriched environment for qualified students who are highly motivated and possess outstanding scholastic ability. Specific requirements for honors degrees are available from the **University Honors Program**, participating departments, and the Office of Undergraduate Academic Affairs.

Dean's List

A student enrolled in the College of Liberal Arts and Human Sciences for 12 hours or more (excluding P/F and repeat courses) who earns a GPA of 3.4 or higher during the fall or spring semester can request from the Undergraduate Academic Affairs Office a Dean's List certificate.

Scholarships

A number of scholarships are available for outstanding students enrolled in the College of Liberal Arts and Human Sciences. Descriptions and deadlines are available on the **college website**. Students who are interested in applying for merit-based financial aid should contact the **Office of University Scholarships and Financial Aid**.

Internships, Study Abroad, and Undergraduate Research

Educational experiences outside the classroom help make students more competitive for internships, jobs, and graduate school applications. Participation in internships, study abroad, and undergraduate research helps prepare students for life after graduation while exposing them to complex cultural issues. Every major offers academic and career advising to support students in connecting with current

opportunities. Contact an academic advisor or faculty member to design an experience or email **liberalarts@vt.edu** to setup an appointment to connect with resources to create an individualized plan. Course credit is available for qualifying experiences.

Career Advising

Career advising is available from multiple sources. The centralized **Career and Professional Development**, located at the Smith Career Center, offers many services to support the career journey. Beginning with career and major exploration, through the process of assisting students in the job search or graduate and professional school application, Career and Professional Development advisors are a resource for all students.

The College of Liberal Arts and Human Sciences works with employers interested in hiring students to host information sessions and panels. Students have the opportunity to attend multiple career fairs offered on campus to build their network, secure internships, or apply for full-time jobs. Every major also offers a **career advisor** who specializes in guiding students toward career success.

Pre-Professional Advising

The University provides pre-professional career advisors for all disciplines and the college provides career advisors in areas related to the College.

- Pre-law advising connects students with faculty advisors, student organizations, and related academic opportunities. The advising program, sponsored by the College of Liberal Arts and Human Sciences, is open to students from all majors who are interested in the law. Students may also select majors that offer pre-law concentrations or degree options to help prepare for graduate programs in law. A pre-law student organization is available for interested students.
- A health professions advisor provides advising on entering professional programs such as medical, occupational therapy, physical therapy, nursing and dental school. The advising program is supported by Career and Professional Development and is open to students in all majors.
- Pre-Education Advising is available for undergraduate students who are interested in pursuing careers in PK-12 education. Because teacher licensure in Virginia is generally a graduate program, the program coordinator provides resources and information for students to plan their undergraduate courses. The advising program, sponsored by the College of Liberal Arts and Human Sciences' School of Education, helps position students for admission to and completion of a graduate degree in education (including teacher licensure).

Graduate Programs

Many of the College of Liberal Arts and Human Sciences departments offer graduate degrees at the Master's and Ph.D. levels. Complete information on these programs, including descriptions of graduate courses, can be found in the **Graduate Catalog**.

Undergraduate Course Descriptions (LAHS)

1004: FIRST YEAR EXPERIENCE: INTRODUCTION TO A RESEARCH UNIVERSITY
Introduces first-year Liberal Arts and Human Sciences majors to the university's research mission and the scope and nature of research within the disciplines in the college. Prepares students to participate in the university's research mission through undergraduate research. Focuses on building problem-solving, inquiry, and integration skills as foundational to academic success. Topics include an introduction to academic support resources, academic planning, career exploration, and e-portfolio. (3H,3C)

1014: ACADEMIC RECOVERY AND SUCCESS STRATEGIES
Helps students on academic probation and/or returning from academic suspension to develop academic

skills, behaviors and motivation towards success; focuses on the development and application of college-level study skills, personal success strategies, and the use of campus resources that enhance individual student achievement. Credit not applicable to meeting degree requirements. (1H,1C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: PROFESSIONAL SEMINAR
Designed specifically for liberal arts and human sciences majors, this course prepares students for careers and/or graduate school. Interviewing, resume writing, the graduate school application process, writing personal statements, electronic job searching, and diversity issues in the workplace are examples of topics covered. Pre: Junior or Senior standing. Major within the College of Liberal Arts and Human Sciences, Junior standing preferred. (1H,1C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Natural Resources and Environment

Course Descriptions & Programs of Study

Dean: Paul M. Winistorfer
Associate Dean: Keith Goyne
Assistant Dean of Business, Finance, and Administration: Candice Albert
Director of Academic Advising: Stephanie Hart

Web: **www.cnre.vt.edu**

Overview

The College of Natural Resources and Environment, through offerings in the Departments of Fish and Wildlife Conservation, Forest Resources and Environmental Conservation, Geography, and Sustainable Biomaterials, provides an integrated education in renewable natural resource management, conservation, and utilization as well as a valuable perspective for understanding and solving critical contemporary environmental problems at local, regional, and global scales.

All undergraduate programs of the College of Natural Resources and Environment are designed to provide a professional education that starts with core courses emphasizing physical, biological, and social sciences, along with concepts of renewable natural resource management. More advanced courses teach the principles and practices of individual disciplines, along with advanced skills in communications and computer use. Students prepare for professional careers with public agencies responsible for predicting the weather and managing forest, water, wildlife, fish, and recreation resources; with private firms concerned with producing, manufacturing, and marketing wood products; with planning agencies and private firms utilizing skills in environmental and land-use analysis and geospatial techniques; or for graduate studies.

Students may develop additional depth of knowledge and specialized skills through completion of options within a major. Majors offered within the college and options for further specialization are provided below:

Department of Fish and Wildlife Conservation

- Fish Conservation
- Wildlife Conservation

Department of Forest Resources and Environmental Conservation

- Environmental Informatics
- Environmental Resources Management
- Forestry
    - Forest Resource Management option
    - Forest Operations and Business option
    - Urban and Community Forestry option

- Environmental Conservation and Society: Water Resources, Policy and Management

Department of Geography

- Geography
- Meteorology

Department of Sustainable Biomaterials

- Packaging Systems and Design
- Sustainable Biomaterials

The college offers minors in Forestry, Urban and Community Forestry, Natural Resource Recreation, Watershed Management, Geographic Information Science, Geography, Meteorology, Sustainable Natural Environments, Wood Science, and Packaging Systems and Design. The college offers pathways minors in Ecological Cities, Blue Planet, Biodiversity Conservation, and Pathways to Sustainability. Contact the respective departments for more information on minors.

Accreditation

The educational programs in Forest Resource Management, Forest Operations and Business, and Urban Forestry qualify graduates as professional foresters and are accredited by the Society of American Foresters, the recognized accrediting body. Graduates in Fish and Wildlife Conservation meet certification requirements of the American Fisheries Society and The Wildlife Society, respectively. The Sustainable Biomaterials major is accredited by the Society of Wood Science and Technology, the recognized accrediting body. The degree in Meteorology was developed from guidelines recommended by the American Meteorological Society and the National Weather Service; the degree meets requirements of the federal civil service (GS-1340) for a meteorologist.

Honors College

The University Honors Program is available to students in the College of Natural Resources and Environment. The program provides enriched opportunities for highly qualified and motivated undergraduate students. Faculty advisors can provide additional information.

Cooperative Education

The college encourages students to become involved in the Cooperative Education Program, in which students alternate on-campus academic terms with off-campus employment in their areas of interest. Additional information is provided in "**Academics**".

Exchange Programs

The College of Natural Resources and Environment participates in reciprocal exchange program with the University of Canterbury in Christchurch, New Zealand. Where appropriate, students can also participate in the International Student Exchange Program.

Graduate Programs

The college offers educational programs leading to the M.S., M.F., MNR, and Ph.D. Complete information on these programs is in the Graduate Catalog.

Undergraduate Course Descriptions (NR)

1114: INTRODUCTION TO RENEWABLE NATURAL RESOURCES

Introduction to careers in forestry, wildlife, fisheries, recreation, and forest products professional fields. Discussion of current global and regional problems affecting natural resource professionals. (1H,3L,2C)

1115-1116 (GEOG 1115-1116): SEEKING SUSTAINABILITY
1115: Strategies to promote sustainability through the identification, description, and analysis of the dominant interconnections within and between environmental, social, and economic systems across local to global scales. 1116: Perceptions of, conditions of, and strategies to analyze processes of change within complex systems, and promote sustainability across local to global scales. (3H,3C)

1234: FIRST YEAR EXPERIENCE IN NATURAL RESOURCES & ENVIRONMENT
Introduction to problem solving related to natural resources and environmental issues. Developing a sense of identity and place within the college while acquiring skills and knowledge that enhance academic success. Exposure to programs on campus that support sustainability and student success. Introduction to a variety of career pathways within natural resources and environmental conservation. (2H,2L,3C)

1984: SPECIAL STUDY
Variable credit course.

2234: 1ST SEMESTER EXPERIENCE-TRANSFER STUDENTS IN NATURAL RESOURCES & ENVIRONMENT
Problem solving related to natural resources and environmental issues, focusing on research, writing and oral presentation skills. Orientation to the college while acquiring skills and knowledge that enhance academic success, including university resources and professional/ personal ethics. Introduction to a variety of career pathways within natural resources and environmental conservation. Restricted to transfer students. (2H,2C)

2554 (FREC 2554) (LAR 2554): LEADERSHIP FOR GLOBAL SUSTAINABILITY
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3954: STUDY ABROAD
Variable credit course.

3964: FIELD STUDY
Variable credit course.

4014 (FREC 4014): NATURAL RESOURCES ECONOMICS
Examination of domestic and international natural resource use, exploitation, and degradation problems, with special focus on use of economics to understand why potential overuse of natural resources exists, and what policy options are available to correct these problems and ensure sustainable natural resource use over time. Water, forests, fisheries, land and exhaustible resources. Permission of instructor may be substituted for the pre-requisite. Pre: ECON 2005 or AAEC 1005. (3H,3C)

4105-4106: LEADERSHIP IN NATURAL RESOURCES
Preparation for leadership roles in the natural resource professions. Introduction to theories of leadership; characteristics of effective leaders; leading and working in interdisciplinary teams. Techniques of meeting facilitation; written and oral communication skills in a leadership context. Effects of preferred modes of interacting with others, perceiving information, making decisions, and approaching tasks on the ability to

lead and work with others. Consent of instructor. Pre: FIW 2114 or FOR 2314 or FREC 2314 or GEOG 3104 or SBIO 2124 for 4105; 4105 for 4 106. (3H,3C)

4444 (GEOG 4444): PRACTICING SUSTAINABILITY
Practicum in sustainability. Synthesize and integrate knowledge from undergraduate career and apply to real world problems of sustainability. Topics and projects selected from opportunities to examine specific local and regional sustainability issues on the VT campus, in the New River Valley and the Commonwealth at large. Pre: Senior Standing. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Pamplin College of Business

Course Descriptions & Programs of Study

Dean: Robert T. Sumichrast
Associate Dean for Administration: Kay P. Hunnings
Associate Dean for Extended Campus: Parviz Ghandforoush
Associate Dean for Research and Faculty Affairs: Kevin D. Carlson
Associate Dean for Undergraduate Programs: Lara Khansa

Web: www.pamplin.vt.edu

Overview

Range of Programs

The Pamplin College of Business offers a Bachelor of Science in Business degree with majors in Accounting and Information Systems, Business Information Technology, Finance, Hospitality and Tourism Management, Management, and Marketing. The College also offers a Bachelor of Science in Real Estate. On-campus enrollment is over 4500 undergraduates and about 200 full-time graduate students in the MS-BA in Business Analytics, Master of Accounting and Information Systems, and Ph.D. programs. The college also enrolls over 200 Evening MBA, about 50 Executive MBA students and about 30 MS-BA students in Hospitality and Tourism at Virginia Tech's National Capital Region campuses located in metropolitan Washington, D.C. as well as about 50 Professional MBA students in classes meeting monthly alternating between Richmond and Roanoke. In addition, the college also enrolls over 700 students in our online Master of Information Technology and about 25 students in the Executive Ph.D. in Business Research with residencies at Falls Church and Blacksburg campuses.

Competitive Advantages of Pamplin

The college offers five distinct competitive advantages:

1. start in the business school from day one
2. graduate with a strong business foundation
3. get jobs (over 90% with a job in their field at graduation)
4. develop skills through hands-on experiences
5. connect with engaged alumni

Groundbreaking Research, Eminent Scholarship

Pamplin faculty members are tackling major issues in industry, finance, management practice, and information technology, to name a few areas. Their research has contributed to greater understanding of business issues, been cited in government hearings and court testimony, and played a role in policy making. Though sponsored research is not a central aspect of the research programs of business schools, several Pamplin faculty members have attracted national funding for their research, working as members of interdisciplinary teams. The college's departments are also regularly ranked among the nation's or world's top programs for scholarly productivity, based on article publication in the leading academic journals in their fields.

Centers

The college offers two centers devoted to helping students and corporations gain more knowledge. The Apex Systems Center for Innovation and Entrepreneurship helps students to learn, lead, and launch. Students will learn to be empowered with skills, tools, and information to create successful ventures. They will launch ventures through support and resources that will help them transform vision to reality. Finally, the center will lead the next generation of entrepreneurs and help them to have courage to build exceptional ventures. The Center for Business Intelligence and Analytics will assist with big data and harnessing analytic techniques to transform raw data into useful information for better business decisions.

Curriculum

The curriculum for the Bachelor of Science in Business degree includes a broad liberal education and business core foundation of two years, followed by a college core in the fundamentals of business theory and concentration in one of the following majors:

- Accounting and Information Systems
- Business Information Technology
- Finance
- Hospitality and Tourism Management
- Management

- Marketing

The Program in Real Estate offers a Bachelor of Science degree in Real Estate, providing an integrated, interdisciplinary degree. Real estate is integral to where one works, shops, lives and recreates. Thus, Real Estate courses integrate the material students learn in disciplinary courses such as finance, law, and property management through experiential learning within the academic program. The integration occurs though a university-industry partnership where real estate professionals are actively involved in students' education through guest lectures, mentoring experiences, and by providing internship opportunities.

Academic Advising

Academic advising is an important aspect of each student's college career. Students are assigned to a professional academic advisor to assist from entry in Pamplin until graduation. All business students are assigned to an advisor in Pamplin Undergraduate Programs, 1046 Pamplin Hall. Real Estate students are assigned to an advisor in the Real Estate program, Bishop-Favrao Hall.

Undergraduates are strongly encouraged to participate in the out-of-class activities of the college, particularly the annual career fairs in September and January, ethics and leadership seminars, college international programs and study abroad, and the various events of the over 30 different student clubs in the college. Many of these programs provide critical insights into the careers for which students are preparing, as well as valuable opportunities for leadership.

Undergraduates are required to bring a computer to the university, as well as purchase university and Pamplin software bundles. The computer is used extensively in the curriculum. Purchase information and required configuration will be available each spring.

Facilities

Administrative and faculty offices for the college are located in Pamplin, Wallace, and Bishop-Favrao Halls. Our facilities also include study rooms, computer labs, conference rooms, a behavioral laboratory, kitchen laboratory, atrium filled with furniture conducive to studying and group work, and a student organization office center.

Accreditation

The college is a member of The Association to Advance Collegiate Schools of Business, AACSB International. All programs are accredited by the AACSB. Additionally, the ACIS program holds an accreditation from AACSB: AACSB Accounting Accreditation. The Finance department is accredited through the Certified Financial Planning Board of Standards, Inc.

General Requirements for Graduation

A minimum of 125 credit hours is required for graduation in the Bachelor of Science in Business degree. The Bachelor of Science in Real Estate requires 120 credit hours.

Students must have an overall average and in-major GPA of 2.0 ("C") to graduate.

To ensure credit, a student desiring to take courses at another institution must secure approval from Pamplin Undergraduate Programs before registering for the course at another institution. Completion of the "Authorization to Take Courses Elsewhere" must be submitted online. The student will be notified of the outcome via email.

General university limitations on acceptability of transfer credit are shown elsewhere in this catalog.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When reviewing degree requirement information, always choose the year of expected date of graduation. Requirements for graduation are referred to via university publications known as "checksheets". The number of credit hours

required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Program for First Two Years

All business degree-seeking students generally take the same required courses for the first two years. Courses consist of business foundation courses as well as general education requirements and free electives. Pamplin enforces a strict policy of progress toward degree (Policy 91). Policy 91 states that students must complete the following courses with grades no lower than C- by the time they have attempted 72 credit hours (90 hours for transfer students): ACIS 1504, MATH 1524, BIT 2405-2406, ACIS 2115-2116, and ECON 2005-2006. Students who do not meet this progress towards degree requirement will be dismissed from their major.

Business Core

All business degree-seeking students take the same business core, regardless of major. The core creates a strong foundation in all aspects of business and includes coursework in accounting, economics, finance, marketing, management, information technology, and international business. All core courses require a grade of C- or better or else the course must be repeated. However, students at the university may only attempt a course three times.

Restricted Majors

ACIS, BIT, FIN, HTM, MGT and MKTG are considered restricted majors and require application from students who did not start at VT enrolled in one of those majors. Students must complete certain business courses and obtain a minimum GPA for eligibility to apply to a restricted major. Applications are accepted online three times per year – January, May, and August.

Pamplin College of Business Minors

Business Minor

Students pursuing a major outside the Pamplin College of Business (with the exception of Real Estate) may apply for a minor in business if they have a minimum 2.0 overall GPA and have completed the math requirement. The minor consists of 40 credit hours of foundational coursework in various areas of business. In order to complete the minor in business, students must have a 2.0 GPA in all required courses.

The requirements to earn a minor in business can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Digital Marketing Strategy Minor

Digital marketing encompasses many areas of application, including mobile marketing, Internet marketing, e-commerce, and social media marketing. The Digital Marketing Strategy minor enables students to acquire knowledge and skills in online and digital business and digital product delivery, as well as development, analysis, and enhancement of a company's presences on the web, mobile, and social networks. The minor is open to all Pamplin College of Business majors and requires 21 credit hours of coursework.

The requirements to earn a minor in digital marketing strategy can be found on the University Registrar

website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Entrepreneurship-New Venture Growth Minor

The Entrepreneurship-New Venture Growth Minor is intended to focus on the knowledge and skills needed to create new ventures and lead their early growth. The objective is to provide students with the knowledge to convert ideas into business successes, particularly in the context of engineering and science-based technology commercialization.

The curriculum consists of eighteen credit hours, including six hours of foundational entrepreneurship coursework, six hours of business-restricted electives, and six hours of restricted electives.

The requirements to earn a minor in entrepreneurship can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Event and Experience Management Minor

The Hospitality & Tourism Pathway's minor in Event and Experience Management is available to all students across campus and provides options of emphasis in sales management or event operations management. The minor consists of 18 hours of study and provides students with content and practical experiences leading to professional growth opportunities in the event management industry. In the United States alone, there are over 18 million events and meetings organized every year creating career opportunities for students who aspire to design, plan and manage the execution of events or for those who prefer the challenge of sales and the techniques involved in building customer relationships through effective communication and interpersonal skills.

The requirements to earn a minor in entrepreneurship can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

International Business Minor

Sophomores, juniors, and seniors in the Pamplin College who have at least a 2.0 overall GPA are eligible for the International Business minor. The minor consists of 18 credit hours of course work, four years of a foreign language (may be satisfied from high school), and an approved international experience.

The requirements to earn a minor in international business can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Leadership Centers and Minors

The **Business Leadership Center (BLC)** within the Department of Management provides multi-disciplinary, experiential education in the history, values, skills, and theory of organizational and team leadership. It acts as an educational center that coordinates programs to help students develop leadership skills that are necessary to excel and prosper in the workplace of the twenty-first century.

The 18-credit minor in Organizational Leadership is open to students in all majors who have at least a 2.5 overall GPA at Virginia Tech. It includes required courses in team and organizational leadership; elective courses that address a broad range of competencies in four areas, including Creativity and Innovation, Critical and Strategic Thinking, Intercultural Communications, and Holistic Thinking and Ethical Reasoning. and a required leadership experiential activity. For additional information, contact Dr. Kimberly Carlson, Business Leadership Center, (540) 231-1279, leadershipcenter@vt.edu.

The requirements to earn a minor in leadership can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Housed within the Virginia Tech Corps of Cadets (VTCC), the mission of the Major General W. Thomas Rice Center for Leader Development is to foster the next generation of public leaders by integrating theory and practice through scholarly dialogue and experiential learning in the areas of leadership, civic responsibility, service, and moral values thus contributing to the development of informed and responsible individuals who are committed to making a difference in their nation and in the world. The Rice Center

oversees the 22-credit leadership Minor Corps of Cadets (LMCC). This minor is only available to graduates of the VTCC. For more information on the minor in leadership, please contact the Rice Center for Leader Development at (540) 231-9455.

Professional Sales Minor

Sales positions are critical to all firms and sales positions are expected to increase by as much as 25% over the next several years. This has created strong competition among employers to recruit the very best graduates. The Professional Sales minor is designed to prepare students to excel in this highly lucrative field. The focus of the program is to provide students with critical communication, interpersonal, and presentation skills key to helping organizations build long-term customer relationships. These skills will be valuable not only to those pursuing sales careers but also to anyone aspiring to managerial positions - positions that involve presentation of plans and ideas, negotiations, and persuasion. This minor requires seven specified courses to be completed with at least a 2.0 GPA overall and within the courses.

The requirements to earn a minor in professional sales can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Real Estate Minor

The Real Estate minor allows students with a general interest in real estate to select a set of courses that will advance their knowledge the industry. The minor requires 19 credit hours in coursework across various disciplines including property management, finance, marketing, building construction, and real estate.

The requirements to earn a minor in real estate can be found on the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html**.

Cooperative Education Programs in Business

The college participates in the Cooperative Education Program in which qualified students may alternate semesters of study in the major with semesters of professional employment. Additional information pertaining to the program is included in the "**Academics**" section of this catalog.

Graduate Programs in Business

Graduate instruction and opportunities for research are offered to students who have bachelor's degrees from accredited colleges. The college offers Master of Business Administration programs, and master's and Ph.D. degrees in all departments. All graduate students are required to attain a satisfactory score on the Graduate Management Admission Test (GMAT).

Preparation for Law

The four-year course work leading to the B.S. in Business degree in any major in the college provides a sound preparation for law school, and pre-law advisors from the Pamplin faculty are provided.

Undergraduate Course Descriptions (BUS)

1984: SPECIAL STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3954: STUDY ABROAD

Variable credit course. X-grade allowed.

3974: INDEPENDENT STUDY
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Science

Course Descriptions & Programs of Study

Physics
Psychology
Statistics
Systems Biology

Dean: Sally C. Morton
Associate Dean for Research: Randy Heflin
Associate Dean for Strategic Initiatives and Graduate Studies: JP Morgan
Associate Dean for Undergraduate Programs: Robin Panneton
Associae Dean for Undergraduate Students: Gary L. Long
Assistant Dean for Finance and Administration: Janet Sanders
Assistant Dean for Advancement: Wade Stokes
Director of the Academy of Integrated Science and Director of Inclusion and Diversity: Michel Pleimling

Web: **www.science.vt.edu**

Overview

The College of Science at Virginia Tech provides students with interdisciplinary training in analytical skills, a comprehensive foundation in the tools of science and the scientific method, and rigorous education in any of a wide variety of scientific fields. Outstanding faculty members conduct research and teach courses in fourteen disciplines leading to baccalaureate and advanced degrees. Coursework from the College of Science further provides a foundation of knowledge in a number of fundamental and advanced subjects for students in all Colleges across the campus. The College of Science also offers academic advising and appropriate

preparatory coursework for students interested in pre-medicine, pre-dentistry, pre-veterinary medicine, and patent or intellectual property law.

Degree Programs

Specific degree programs include:

- Biochemistry (B.S.)
- Biological Sciences (B.S.)
- Chemistry (B.S. or B.A.)
- Computational Modeling and Data Analytics (B.S.; option in Physics, track in Economics)
- Economics (B.A.)
- Geosciences (B.S.; options in Geology, Geochemistry, Geophysics, Earth Science Education)
- Mathematics (B.S.; options in Traditional Mathematics, Applied Computational Mathematics, Applied Discrete Mathematics, and Mathematics Education)
- Microbiology (B.S.)
- Nanoscience (B.S)
- Neuroscience (B.S.; Clinical Neuroscience, Computational and Systems Neuroscience, Cognitive and Behavioral Neuroscience, Experimental Neuroscience)
- Physics (B.S. or B.A.; options in Physics Education, Pre-Law, Pre-Health)
- Psychology (B.S.)
- Statistics (B.S.)
- Systems Biology (B.S.)

In addition to traditional majors, the college offers courses in intellectual property law, and supports research centers in areas such as biomedical and public health sciences, applied mathematics, macromolecular science, and many other critical technologies and applied sciences that interface with other Colleges at the University. Allied disciplines emphasize the study of behavioral science as well as economic and strategic decision making. The College is committed to providing research opportunities for interested students at all levels.

The college offers minors in:

- Actuarial Science
- Astronomy
- Biological Physics
- Biological Sciences
- Chemistry
- Economics
- Geosciences
- Mathematics
- Nanoscience
- Physics
- Psychology
- Science, Engineering, and Law
- Statistics

A Leadership minor is available to members of the Corps of Cadets.

General Requirements for Graduation

A student in the College of Science must complete at least 120 hours for an undergraduate degree as well as satisfying the following requirements:

- achieve a minimum overall Grade Point Average (GPA) established for their degree by the major department for all hours attempted
- achieve a minimum in-major GPA established for their major by the department for all hours attempted in all work applied to the major
- complete all other requirements established for their degree by the major department
- complete all college and Curriculum for Liberal Education requirements

No course required for the major/minor may be elected to be taken on a pass/fail (P/F) basis (i.e., pass/fail may be used for free electives only). This excludes courses that are offered P/F only.

College Core Curriculum

A description of the General Education Requirements (Curriculum for Liberal Education) may be found in the Academics chapter of this catalog or on the Curriculum for Liberal Education website (www.cle.prov.vt.edu). College Specific Requirements related to the Curriculum for Liberal Education (CLE):

Area 6: Creativity and Aesthetic Experience

- Satisfactorily complete a three-credit hour course approved for the university Curriculum for Liberal Education. (The one-credit courses for the CLE will not fulfill this requirement.)

Foreign Language· Must complete the third year (level III) of a single foreign language [including Sign Language (ESL)] in a secondary school. This requirement may also be fulfilled by successful completion of one of the following:

- Satisfactorily complete 1106 for any foreign language offered including any prerequisites
- Satisfactorily complete an accelerated course which combines 1105 and 1106 of a foreign language
- Students who have not completed two (2) units of a single foreign language in high school must satisfactorily complete 1106 or an accelerated course which combines 1105 and 1106 of a foreign language. These hours are in addition to the 120 hours required for graduation, so these hours will not count towards graduation.
- Credit by examination for a foreign or classical language. The credit by examination option is available only to students who have gained knowledge of a foreign language without the benefit of formal training. This option is intended to recognize informal, non-academic learning experience. This option is restricted and does not carry credit towards graduation. Requests must be made through the Foreign Language office. See http://www.collegeboard.com/student/testing/clep/about.html for available tests and procedures.
- Students whose native language is not English may be exempted from the foreign language requirement through demonstrating satisfactory knowledge of the foreign language as prescribed by the Department of Foreign Languages and Literatures. All requests for exemption should be addressed to and must be approved by the head of the Department of Foreign Languages and Literatures. This option does not carry credit towards graduation.

Satisfactory Progress

In addition to the university and to the departmental criteria (see specific departments in this chapter), all students in the College of Science are evaluated for continued enrollment at Virginia Tech. The two College of Science criteria for satisfying progress toward degree state that:

1. Students who have attempted 72 semester hours must have completed their foreign language requirement by the close of the academic year (Spring Semester), and
2. Students must have completed all credits for the Curriculum of Liberal Education by the time 96 semester hours have been attempted.

Honors College

The Honors College welcomes highly motivated College of Science students. The mission of the Honors College is to inspire and facilitate an extraordinary education for students of exceptional ability who seek to be active learners and who will apply their knowledge and skills to critical real-world problems.

Currently enrolled Virginia Tech students will receive an invitation to apply to the Honors College at the end of each fall or spring semester, provided they have achieved a 3.60 or better cumulative GPA and have at least four (4) semesters remaining at Virginia Tech before they graduate. More information about honors academic requirements and how to earn an honors diploma is available on the Honors College website: **http://www.honorscollege.vt.edu/index.html**.

Integrated Science Curriculum

Designed for students seeking an in-depth understanding of 21st century science, the Integrated Science Curriculum (ISC) provides a novel, integrated scientific foundation for any degree program in the College of Science. It employs a collaborative, active-learning environment emphasizing teamwork, skill acquisition, independent thought, and creativity. Structurally, ISC is a 30-credit two-year course sequence that covers the fundamentals of college-level chemistry, physics, and biology integrated with each other and with calculus and linear algebra. Teamwork, written and oral presentation, and problem-solving are central components throughout the curriculum.

College Level Minors

Minor in Actuarial Science
www.stat.vt.edu/undergraduate/actuarial-science.html

Actuaries combine knowledge from statistics, finance, and business to assess risk and help create policies that minimize financial risk for individuals and companies. The actuarial profession is consistently ranked near the top of most desirable professions. Please visit the University Registrar website at www.registrar.vt.edu/graduation/checksheets/index.html to view the minor checksheet detailing requirements.

Minor in Science, Engineering, and the Law
www.science.vt.edu/ais/stl

The rights of inventors and authors to royalties for patents and copyrights are protected by intellectual property (IP) law. Today, intellectual property has become a major part of the world's economy and one of the fastest growing areas of law: stem cell research, gene patents, clean technology, file sharing, digital libraries - every day we are faced with a new issue at the intersection of science, technology, and the law. The minor in Science, Engineering, and the Law trains students in the fundamentals of IP law. It identifies and discusses myriad issues that all students who work in the realm of discovery, and who may develop patentable products, need to have knowledge of. This minor is housed in the Division of Science, Technology, and Law within the Academy of Integrated Science.

Dean's List

An undergraduate student who attempts at least 12 credit hours graded on the A-F option and who earns a 3.4 GPA for either spring or fall semester will be included on the online Dean's List for that term. Please note: Students will not appear on the online Dean's List if they are listed in the system as confidential or if they do not have an active permanent address. Questions about omissions from the online list should be directed to the Office of the University Registrar.

Pre-Professional Advising in the College of Science

Career and Professional Development offers advising to all students who are considering graduate or

professional school as part of their career planning process. Students are welcome to seek advising for decision-making on whether graduate school is the path to their career goal, how to research school and programs, and reviews resumes and personal statements. Students interested in any health profession requiring graduate or professional school are encouraged to participate in health professions advising **www.career.vt.edu/HealthProfessionsAdvising/Index.html**. Health professions advising is particularly helpful in advising students interested in nursing, dentistry, optometry, veterinary medicine, allopathic medicine (MD), osteopathic medicine (OD), physical therapy, becoming a physician's assistant/nurse practitioner, etc. Advising for students interested in patent or intellectual property law careers is available in the college advising center.

Phi Beta Kappa

Phi Beta Kappa is the oldest and most prestigious honor society dedicated to recognizing excellence in the liberal arts and sciences. Students in the College of Science who have exhibited outstanding academic ability in eligible coursework may be eligible for selection to Phi Beta Kappa.

Scholarships

A number of scholarships are available for outstanding students enrolled in the College of Science. Descriptions and deadlines are available on the Scholarships and Financial Aid website.

Undergraduate Research

Research opportunities and experiencing the excitement of discovery can play an important part in undergraduate training in science. College of Science departments offer diverse research opportunities in which students may choose to participate. Individuals interested in undergraduate research should contact a faculty member in the department where they wish to conduct research.

Internships, Co-op Opportunities, and Enrichment Programs

Students are encouraged to participate in internship and co-op opportunities to gain relevant work experience prior to graduation. Career advisors in the college advising center as well as departmental career advisors can help students identify opportunities. In some cases, students can receive credit for qualifying work experience. Enrichment studies include field station opportunities, study abroad and summer laboratory experiences outside of the university.

Career Advising

Career advising is available from a number of sources. The centralized Career and Professional Development, located at the Smith Career Center, offers many services to aid with your career journey. Beginning with career and major exploration early in your time on campus, through the process of assisting you in the job search or graduate and professional school application, Career and Professional Development advisors can be a resource for you along the way. Career advisors have resources to guide your every step in the career journey, as well as assisting in gaining valuable experience through internships and other opportunities in your career field(s) of interest. Specialized Health Professions Advisors are also available for those that are choosing to pursue post-graduate education in a Health Profession. For more information, visit **www.career.vt.edu**. The departments within the College of Science also host panels and information sessions with employers interested in hiring students with degrees from the college. Every major has departmental advisors who specialize in guiding students from their field towards career success.

As part of a service to you, Career and Professional Development offers each student a FREE Hokies4Hire account. Students who are seeking any type of career-related experience or employment, including internships, co-ops, career-related summer employment, and permanent positions are eligible to use Hokies4Hire. You may upload your resume, search for companies interested in Virginia Tech students, apply

for positions, review job fairs, and sign up for on-campus interviews listed in Hokies4Hire. Additional information about this resource can be found at **http://www.career.vt.edu/H4H**.

Graduate Programs in Science

College of Science departments offer graduate degrees at both the Master's and Ph.D. levels. Complete information on these programs including descriptions of graduate courses can be found in the **Graduate Catalog**.

Undergraduate Course Descriptions (COS)

1015-1016: SUCCESSFUL STARTS IN SCIENCE: CURIE & DA VINCI LIVING LEARNING COMMUNITIES
First year experience course for students living in the Curie or Da Vinci Living Learning Communities at Virginia Tech. Provides resources and fundamental skills to enhance learning experiences and support academic success in the sciences. Engages students with professional and academic development activities both in the classroom and within a science-themed residence hall. Uses a "learn by doing" approach to blending technical know-how with leadership, ethical, interpersonal and professional skills fundamental to the practice of science. Requires teamwork to envision, design, and implement research projects while using innovative discipline-specific technology. Provides first-year students with support through a weekly peer mentoring program. 1015: Emphasis on scientific inquiry, curriculum planning, career planning in the sciences, skills to promote academic success, awareness of academic and career resources and opportunities. 1016: Emphasis on collaborative problem-solving skills using innovative discipline-specific technology, critical thinking; Integration of ideas and experiences to encourage life-long learning through service work related to their academic/ career interests. (1H,1C)

1984: SPECIAL STUDY
Variable credit course.

2015-2016: PROFESSIONAL LEADERSHIP IN SCIENCE: CURIE & DA VINCI LLC LEADERSHIP COURSE
Leadership and professional development course for sophomore science majors in the Curie and Da Vinci Living Learning Communities (LLCs). Applied experience in fundamental leadership and project management skills associated with practice of science, gained through service learning within the LLC. 2015: Academic peer mentoring, application and development of leadership and communication skills; applicationi and development of project planning, organizational and collaboration skills; emphasis on written communication skills. 2016: Application of team mentoring and project management skills, including project planning and coordination, leadership strategies, collaboration, communication, conflict resolution, understanding group dynamics and the importance of diversity, and facilitating group discussion on scientific problem solving; emphasis on verbal communication skills. Pre: 1016 for 2015; 2015 for 2016. (1H,1C)

2164 (ENGR 2164): INTRODUCTION TO SCIENEERING
Seminar-based course providing a survey of current interdisciplinary science and engineering research problems; introduction to interdisciplinary thinking and communication; issues related to interdisciplinary research teams. (1H,1C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

4064 (ENGR 4064): SCIENEERING CAPSTONE
A capstone experience centered around an open-ended, faculty-advised senior project involving the design of a process, material, or technique for solving an interdisciplinary problem. Pre: Enrollment in Interdisciplinary Engineering and Science Minor. Pre: ENGR 2464 or BIOL 2124. (3H,3C)

4304: PATENT LAW
The protection and enforcement of patent law, U.S. case law that interpret Sections 35 of the US Statutory code; Analysis of the goals and costs of the patent law system; patentability requirements, infringement, remedies, patent prosecution issues, and patent transactions; Patent and intellectual property strategies. Pre: 2304. (2H,2C)

4324: GLOBAL ASPECTS OF INTELLECTUAL PROPERTY LAW
Comparative study of international intellectual property systems; international treaty arrangements for copyrights, patents and trademarks; protection and enforcement of intellectual property rights in foreign markets; policy analysis of the globalized intellectual property system. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (ISC)

1004: INTEGRATED SCIENCE CURRICULUM ORIENTATION SEMINAR
Introduction to the different fields of science and mathematics, and academic and career planning for College of Science majors that are enrolled in the Integrated Science Curriculum. Discussion of academic plans and university and college requirements. Resume building for internships, research experiences, and graduate school. Exposure to areas of practice and research, and opportunities for education, training, and employment in fields of interest to students graduating from the College of Science. (1H,1C)

1105-1106: INTEGRATED SCIENCE I
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. Application of these principles to large-scale societal problems, including the areas of food, energy, health, water, the environment, and more. 1105: Discrete dynamical systems, differentiation and integration, differential equations, population dynamics, chemical reactions, chemical kinetics, Newton's laws, linear and rotary motion, kinetic and potential energy. 1106: Genetics, evolution, molecular biology, organic chemistry, biochemistry, thermodynamics, gases, heat engines, oscillations. Co: 1115 for 1105; 1116, 1116 for 1106. (6H,6C)

1115-1116: INTEGRATED SCIENCE LABORATORY I
Laboratory component of Integrated Science Curriculum where students conduct project-based interdisciplinary laboratories organized into content modules. Discussion of ethical issues connected to scientific advances. 1115: tools of scientific research, water, ecology, kinetics. 1116: tools of scientific research, environmental chemistry, surfactants, nanomedicine. Co: 1105 for 1115; 1106 for 1116. (6L,2C)

1224: DIFFERENTIAL AND INTEGRAL CALCULUS FOR THE INTEGRATED SCIENCE CURRICULUM
A course for students in the Integrated Science Curriculum needing MATH 1225 content not covered in the ISC sequence. Limits and continuity, derivatives of trigonometric and logarithmic functions, Newton's method, applied optimization, definite and indefinite integrals. Partially duplicates MATH 1225. Co: 1105. (2H,2C)

2105-2106: INTEGRATED SCIENCE II
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. 2105 Molecular cell biology, metabolism, photosynthesis, membrane transport, quantum theory, spectroscopy, elasticity, waves, fluids, electricity and magnetism, linear algebra, genomics, probability theory. 2106: Gene regulation, signal transduction, development, motility, intramolecular forces, stochastic processes,

optics and microscopy, materials science, analytical tools. Restricted to majors in the College of Science. Only by permission of the instructor. Pre: 1106H for 2105; 2105, 2105 for 2106. (6H,6C)

2115-2116: INTEGRATED SCIENCE LABORATORY II
Laboratory component of Integrated Science Curriculum where students conduct project-based interdisciplinary laboratories organized into content modules. 2115: Tools of Scientific Research, Genomics and Proteomics, Nanoscience, and Electromagnetism. 2116: Tools of Scientific Research, Neuroscience, Optics, and Independent Research Project. Pre: 1116 for 2115; 2115 for 2116. Co: 2105 for 2115; 2106 for 2116. (3L,1C)

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (STL)

2304: FOUNDATIONS OF SCIENCE, TECHNOLOGY & LAW
US legal system and the rule of law; legal research, analysis, and writing; history, evolution, and moral justifications of intellectual property; intellectual property as it relates to innovative and creative activity; ethical and social issues surrounding intellectual property. Pre: ENGL 1106 or ENGL 1204H. (3H,3C)

4304: INTELLECTUAL PROPERTY LAW
Comprehensive study of the principal legal theories and moral justifications relating to the protection and infringement of intellectual property, including copyrights, patents, trademarks, and related state and federal doctrines (e.g. trade secrets); analysis of commonalities and differences between the different rights; interpretation and application of relevant statutes, rules, and cases; challenges that are posed by new technologies. Pre: 2304. (3H,3C)

4314: CURRENT TOPICS IN SCIENCE, TECHNOLOGY & LAW
Current developments, problems, and cases at the intersection of science, technology & law; particular focus is placed on intellectual property law and on social, ethical, and other legal issues prompted by new technologies and scientific advancements. Topics include copyright protection in a digital environment; patent law challenges such as patent trolls, patent thickets, ethical considerations related to patenting of life forms; design patents; innovation policy and economic considerations; intellectual property reform efforts; advanced discourse. Pre: 2304 or 4304 or 4324. (3H,3C)

4324: GLOBAL ASPECTS OF INTELLECTUAL PROPERTY LAW
Comparative study of international intellectual property protection and enforcement; international treaty arrangements for copyrights, patents and trademarks; policy analysis of the globalized intellectual property system; discussion of global challenges such as access to knowledge, access to essential medicines, adequate protection of geographical indications. Pre: Senior standing. (3H,3C)

4334: PATENT PREPARATION & PROSECUTION
Practice of patent law, specifically procedural and substantive laws, rules, and procedures relating to patent application, patent prosecution, and patent maintenance. Filing and prosecuting patents. Ethical issues relating to patent practice. Preparation to take US Patent and Trademark Office's (USPTO) Patent Bar Examination. Pre: 4304. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (TBMH)

4964: FIELD WORK/PRACTICUM
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

College of Veterinary Medicine

Dean: Gregory Daniel
Associate Dean for Professional Programs: Jennifer L. Hodgson
Associate Dean for Research and Graduate Studies: S. Ansar Ahmed
Assistant Dean for Administration: April G. Hylton
Associate Dean: Xiaoping Zhu
Professors: J. G. Barrett, M. Borgarelli V. A. Buechner-Maxwell, , M. F. Ehrich, J. L. Hodgson, L. Hungerford, O. I. Lanz, M.L. Larson, M. Lee, M. S. Leib, D. S. Lindsay, X. J. Meng, W. E. Monroe, D. L. Panciera, K. D. Pelzer, J. P. Pickett, R.S. Pleasant, K. Redican, J. H. Rossmeisl, S. Samal, G. G. Schurig, S. A. Smith, D. P. Sponenberg, N. Sriranganathan, W. S. Swecker Jr., N. A. White II , J. R. Wilcke, X. Zhu, L. Yuan, A. M. Zajac, K. Zimmerman
Associate Professors: I. Allen, A.S. Bertke, D. Blodgett, , K. Boes, C. Byron, C. Caswell, S. G. Clark, L.A. Dahlgren, J. Davis, N.G. Dervisis, F. ElNady, L. Eng, M. Erskine, L. E. Freeman, , J. M. Gohlke, D.C. Grant, P., J-Q He, N. Henao Guerrero, I. P. Herring, K. Hosig, W. R. Huckle, B. G. Klein, K. Lahmers, Y. W. Lee, X. Lou, H. C. McKenzie III, D. M. Moore, N. Nanthakumar, K. Oestreich, U. Pal, Y. Pan, J. Patton, P. Pithua, G. K. Saunders, W. K. Scarratt, B. J. Smith, N. Tablante, M.H. Theus, S. G. Witonsky, H. Xie, Y. Zhang
Associate Professors of Practice: T. Burns, V. Ragan
Assistant Professors: C. Baker , L.E. Bartl, G. Belov, , A. S. Bertke , T. Bolton, R. Carpenter , K. S. Clapp, L. Corcoran, V. K. Corrigan, S. Coutermarsh-Ott, S. DeMonaco, L. Duff , N. Duggal, M. Freeman, S, Khattar, X. Luo, S. McDonald, P. Morton, N. Muro, M. T. Nappier, D. Nelson , N. D. Pavlisko, J. Pelzer, C. Rist, J. D. Ruth, Z. Sheng, M. Shi, K. Stadler , J. Stewart. S. Swanger, J. Tuohy, S. Werre, J. Zambriski

Research Associate Professor: W. Eyestone
Research Assistant Professors: R. Dai, J. M. Green, T. Hrubec, S. Kenney, S. Kim, M. R. Prater, C. Reilly, B. Rzigalinski, K. Shin-Hee, K. Sunil, J. Weger-Lucarelli and X. Yang
Research Scientist: N. Evans and W. Li
Collegiate Assistant Professor: A. Smith
Clinical Professor: T. LeRoith
Clinical Associate Professors: S. Barry, K. Boes, J. Brown, T. Cecere, J. F. Currin, M. Erskine, R. Funk, S.L. Klahn, S.M. Lahmers, T. LeRoith, T.E. Pancotto
Clinical Assistant Professors: M. Norris Adams, S. Barrett, J. Cecere, S. Bogers, J. Cecere, K. Estell, R.M. Rodriguez Galarza, S.R. Guynn, S. Hafez, M. Kelleher, J. L. Petrovitch, D. R. Reeder, D. Sawyere, H. Schramm, M. Shepherd, M. Shi , H. Tham, K. E. Wilson
Clinical Instructors: A.U. Arendse; M. Brookhart, R. E. Carpenter, V. Edwards, R. Foster, H. Jeong, E. MacDonald, F. Rodriguez, E. Schaefer, J.D. Wilson
Biomedical Engineering Instructor: T. Gillian
Lecturer: S. Wenzel
Adjunct Faculty: A. Bahamonde, S. Barker, I. Becvarova, C. Bissett, M. J. Bowen, C. Broaddus, K. Cooper-Bailey, B. Costa, M. V. Crisman, L. Crofton, J. C. Gutierrez Toro, T. Inzana, T. Johnson, J. C. Jones, T. M. Kerkering, N. M. Lindstrom, K. MacDonald, C. J. McNeill, P. Michalak, J. Moody, S. L. Porter, G. Rajagopalan, S. Rao, B. Robert, A. Sage, S. Santamaria, S. Schwartz, J. Sleeman, S. J. Stahl, M. L. Tilghman, D. Villegas, J. Walters, J. Weisman

Web: **www.vetmed.vt.edu**

Overview

Founded by the Virginia General Assembly in 1978, the Virginia-Maryland Regional College of Veterinary Medicine is a regional school for the professional training of veterinarians which has been built upon the strong foundations of two of the nation's leading land-grant universities: Virginia Tech in Blacksburg and the University of Maryland at College Park. The College operates three campuses, including the main campus facilities at Virginia Tech, the Avrum Gudelsky Veterinary Center at College Park, and the Marion duPont Scott Equine Medical Center in Leesburg.

Graduate Programs

The graduate program leads to the M.S. and Ph.D. in biomedical and veterinary sciences. The goal of this program is to enhance the research capabilities of the graduates so that they can conduct independent research and associated societal endeavors aimed at solving biomedical problems related to veterinary medicine. These individuals will be expected to make scientific contributions in academia, research, and animal health administration.

For additional information, contact the Graduate School via e-mail at **vmsgrad@vt.edu**.

Professional Program

Students desiring admission to the four-year professional program leading to the D.V.M. degree must show evidence of intellectual ability and achievement, as well as personal preparation for the curriculum and the profession. Because the number of applicants greatly exceeds the number of spaces in entering classes, only those who demonstrate such qualifications to a high degree will be selected. Most entering students will have completed three or more years at an accredited university by the time of matriculation; however, applications will be accepted from students who have completed at least 60 semester hours or 90 quarter hours of university credit by the end of the spring term of the year for which application is being made, and who have a grade point average of at least 2.8 on a four-point scale. Exceptional students with the minimum university course work are encouraged to apply.

A number of college courses, with laboratory classes, are required for entry into the DVM program including biological sciences, organic chemistry, and physics. Two (2) consecutive semesters are in general biology and physics, and a one semester course in organic chemistry are required. A one-semester course in biochemistry will meet the minimum requirement for entry.

Further courses required include 6 semester hours or 9 quarter hours of college-level courses in English, mathematics, and humanities/social sciences, and a 1 credit course in medical terminology. In addition, many courses contributing to a well-rounded liberal education are of direct value and, although proficiency in the sciences is essential to the understanding of veterinary medicine, concentration on the sciences at the undergraduate level is not essential. Suggested electives include: microbiology, or physiology. Since veterinary medicine also is concerned with a variety of social, environmental, and community activities, a broad cultural background is important. Basic computer skills are highly desirable.

Admissions inquiries should be directed to:

Jacque Pelzer, D.V.M.
Director of Admissions and Student Services

Ms. Shelby Jenkins
Admissions Coordinator

Admissions Office
Virginia-Maryland Regional College of Veterinary Medicine
Virginia Tech
Blacksburg, VA 24061
Phone: (540) 231-4699
E-mail: dvmadmit@vt.edu
Web: **www.vetmed.vt.edu**

Public Health Program

Virginia Tech's Public Health Program in the Department of Population Health Sciences is administered by the Virginia-Maryland College of Veterinary Medicine in partnership with the Virginia Tech Carilion School of Medicine and is accredited by the Council on Education for Public Health.

The Master of Public Health professional degree program integrates and expands public health offerings at Virginia Tech and enhances the university's track record of addressing vital public health issues through learning, discovery, and engagement.

The program is grounded in an interdisciplinary "One Health" approach. One Health recognizes the dynamic interdependence of human, animal, and environmental health and encompasses the interdisciplinary efforts of medical, veterinary, environmental health, and public health professionals to protect, promote, and improve health. Students gain the requisite knowledge and skills to examine the human, animal, and environmental factors that contribute to the control and prevention of disease and the promotion, enhancement, and maintenance of health.

For additional information, please contact the Public Health Program at **phs@vt.edu** or by phone at (540) 231-3945.

Professional Program Courses

Professional program courses leading to the D.V.M. degree carry the veterinary medicine (VM) prefix. For updated information on the DVM Curriculum, please see our website at: **http://www.vetmed.vt.edu/academics/dvm/dvm-curriculum.asp**.

8164: Normal Animal
8174: Dealing with Threats
8184: Becoming a Professional I
8234: Fundamentals Of Nutrition
8254 (BMVS 5814): Functional Morphology Birds, Reptiles
8264: Small Animal Nutrition
8274: Topics In Veterinary Pharmacology
8284: Veterinary Musculoskeletal System
8304: Veterinary Pathology I
8314 (BMVS 5244): Fundamentals Of Veterinary Pharmacology
8324 (BMVS 5744): Veterinary Parasitology
8334 (BMVS 5754): Veterinary Bacteriology & Mycology
8344: Veterinary Opthalmology
8354: Veterinary Clinical Techniques
8374: Fundamentals of Theriogenology
8384: Food Animal Nutrition
8394 (BMVS 5844): Equine Nutrition
8404: Veterinary Pathology II
8414 (BMVS 5734): Clinical Pathology
8424 (BMVS 5254): Veterinary Toxicology
8434: Veterinary Public Health
8444: Veterinary Anesthesiology
8454: Veterinary Clinical Nutrition
8474: Reproductive Pathology
8485-8486-8487: Bovine Reproductive Management
8494: Aquatic Medicine/Fish Health
8514 (BMVS 6514): Equine Theriogenology
8524: Equine Clinical Problem Solving
8534 (BMVS 5564): Introduction To Clinical Research
8544: Veterinary Radiology
8554: General Veterinary Medicine
8574: Food Animal Theriogenology
8585, 8586, 8587: Small Animal Medicine

8594: Wildlife Medicine
8614: Veterinary Gastroenterology
8615, 8616: Food Animal Medicine And Surgery
8624: Veterinary Surgical Principles and Practicals
8644: Urology
8654: Veterinary Neurology
8674: Vet Hemolymphatic System
8684 (BMVS 6554): Advanced Epidemiology
8694: Advanced Small Animal Techniques
8695, 8696: Equine Medicine And Surgery
8754 (BMVS 5864): Veterinary Cardiorespiratory System
8764: Veterinary Dermatology and Endocrinology
8784: Clinical Pharmacology
8804: Complementary Medicine
8874: Ferret Medicine & Surgery
8984: SS-Professional Foundations
8984: SS-Professional Foundations II
8984: SS-Veterinary Genetics
8984: SS-Vets in Global Community
8984: SS-Beef Cow-Calf Institute
8984: SS-Professional Foundations III
8984: SS-Professional Foundations IV
8984: SS-Emerging & Exotic Dis of An
8984: SS-Veterinarians & Public Policy
8984: SS-International Clinical VM
8984: SS-Professional Foundations V
8984: SS-Public Corp Problem Solving
8984: SS-SA Behavorial Medicine
8984: SS-Parasitology of Grazing Animals
8984: SS-Equine Field Services Clerkship
8984: SS-Dairy Herd Mgmt Clerkship
8984: SS-Beef Herd Mgmt Clerkship
8984: SS-CVM Externship Clerkship
8984: SS-Federal/State Government
8984: SS-Research/Diagnostics
8984: SS-Institutional Applied Clinical Med
8984: SS-Corporate/Associate/Admin
8984: SS-International Public Corporate
8984: SS-Oncology Clerkship
8984: SS-Theriogenology Clerkship
8984: SS-SA Emergency Medicine
8984: SS-Equine Podiatry
9004: Avian Medicine And Surgery
9034: Advanced Small Animal Surgery
9044: Food Animal Clinical Problem Solving
9064: Advanced Histopathology
9074: Goat And Sheep Medicine
9085-9086 (BMVS 5005-5006): Emerging Infectious Diseases
9094 (BMVS 6564): Advanced Veterinary Public Health
9124: Advanced Equine Theriogenology
9134: Advanced Small Animal Surgery Lab

9144: Problem Solving In Small Animal Medicine
9174: Equine Neonatology & Pediatrics
9224: Clinical Applications In Exotic Animal Medicine
9254: Small Animal Theriogenology
9264: Small Animal Community Practice Clerkship
9404: Specialty Medicine Clerkship
9424: Avian Medicine Elective Clerkship
9434: Small Animal Medicine Clerkship
9454: Veterinary Ophthalmology Elective Clerkship
9504: Large Animal Clinical Services Clerkship
9534: Production Management Medicine Clerkship
9544: Equine Medical Center Clerkship
9574: Production Mgt Medicine Elective Clerkship
9594: Theriogenology Elective Clerkship
9604: Sm. Ruminant/Pseudoruminant Elec. Clerkship
9614: Small Animal Surgery Clerkship
9624: Anesthesiology Clerkship
9634: Radiology Clerkship
9644: Small Animal Private Practice Clerkship
9714: Govt & Corp. Veterinary Medicine Clerkship
9724: Laboratory Services Clerkship
9744: Morphologic Pathology Elective Clerkship
9804: Food Animal Private Practice Clerkship
9814: Equine Private Practice Clerkship
9824: Mixed Species Private Practice Clerkship
BMVS 4014: Animal Domestication
BMVS 4024: Diseases of Poultry
TBA: Cardiology Clerkship
TBA: Dermatology Clerkship
TBA: Neurology Clerkship

Undergraduate Courses (BMSP)

2135-2136: HUMAN ANATOMY & PHYSIOLOGY
Structure and function of the human body for students preparing for professions in the health fields. 2135: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2136: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2135-2136 duplicates BIOL 2405-2406; may not receive credit for both. Pre: (BIOL 1005 or BIOL 1006) or (BIOL 1105 or BIOL 1106) or (BIOL 1205H or BIOL 1206 H) for 2135; 2135 for 2136. (3H,3C)

2145-2146: HUMAN ANATOMY AND PHYSIOLOGY LABORATORY
Laboratory exercises investigating the structure and function of the human body for students preparing for professions in the health fields. 2145: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2146: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2145-2146 duplicates BIOL 2414; may not receive credit for both. Co: 2135 for 2145; 2136 for 2146. (3L,1C)

4974: INDEPENDENT STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Courses (BMVS)

2994: UNDERGRADUATE RESEARCH
Variable credit course.

4014: ANIMAL DOMESTICATION AND GENETIC RESOURCES
Considers the process, history, sociology and geography of animal domestication. Includes behavioral, physiologic and morphological changes incurred by domesticated stocks. Examines genetic variability of domestic species, considers breed groups and uniquely adapted breeds. Considers reasons for erosion of genetic variability and mechanisms to counteract such erosion. International in scope. Pre: senior status or enrollment in veterinary professional curriculum. (1H,1C)

4024: DISEASES OF POULTRY
Biology control and prevention of poultry diseases. Taught alternate years. (2H,2C)

4054: LABORATORY ANIMAL MANAGEMENT
This course involves a study of the principles of laboratory animal science, providing the student with a basic understanding of the laws and regulations governing the care and use of animals, husbandry and surgery of a variety of lab animal species, and variables which can adversely affect animal research. Through formal lectures, discussions, and laboratory sessions, the course is designed to complement graduate studies in biological, biomedical, and life sciences which involve the use of animals in research. (2H,3L,3C)

4064 (BMES 4064): INTRODUCTION TO MEDICAL PHYSIOLOGY
An introductory course to the principles of medical physiology, designed primarily for -- but not limited to -- undergraduate and graduate students majoring in biomedical engineering, and other related engineering and physical sciences majors with little or no formal background in biological sciences. The focus is on basic principles and concepts of physiology with a special emphasis on the interactions of human systems biology in their entirety rather than individual genes and pathways. Not intended for students expecting to major in biology or planning to enter health professional fields. Pre: Junior standing or permission of the instructor. (3H,3C)

4074: PHARMACOLOGY
A basic course in the science of pharmacology, intended to provide an understanding of the mechanisms of action and physiological systemic effects of major classes of drugs of biological, agricultural, social, and medical importance. Must have prerequisites or equivalent. Pre: CHEM 2514 or CHEM 2535 or ALS 2304 or BIOL 2406. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section Variable credit course.

Undergraduate Courses (PHS)

1514: PERSONAL HEALTH
Fundamental health content and theory to provide students with constructive health information necessary to meet current and future personal health needs. Special emphasis on wellness and health promotion. (3H,3C)

2004: INTRODUCTION TO PUBLIC HEALTH
Examination of how public health core disciplines of epidemiology, health policy and administration, health behavior, and environmental health work together in addressing public health problems. Special emphasis on the history of public health, the public health infrastructure and role of health informatics in public health. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Variable credit course.

3014: INTRODUCTION TO ENVIRONMENTAL HEALTH
Overview of environmental health, examining local, national, and international frameworks. Environmental factors that affect human health, including major classes of chemical, biological, and physical exposures from different environmental media (air, water, food, and soil). Special emphasis on toxicology and epidemiology methodologies used at the individual (mechanistic) level and at the population level to determine environmental causes of disease. Find the most appropriate prevention or control measure to minimize adverse health outcomes. (3H,3C)

3064: PUBLIC HEALTH SEMINAR
Current topics in public health research, policy and practice, including biostatistics, epidemiology, health policy, environmental health, social and behavioral medicine, infectious diseases, and public health education. Pass/Fail only. Pass/Fail only. (1H,1C)

3534: DRUG EDUCATION
Interpretation of multidimensional (social, psychological and physiological) scientific data regarding drugs. The major drug categories will be covered with special emphasis on substance misuse and abuse. (3H,3C)

3634 (HNFE 3634): EPIDEMIOLOGIC CONCEPTS OF HEALTH AND DISEASE
Designed to give students in the health sciences a basic understanding of the modern concepts regarding health and disease as well as skills in organizing epidemiological data, disease investigation and surveillance. Includes a survey of terms, concepts, and principles pertinent to epidemiology. Lifestyles of populations and the relationships between lifestyles and health status are studied. (3H,3C)

3964: PRACTICUM
Variable credit course. X-grade allowed.

4014: PUBLIC HEALTH PROGRAM PLANNING AND EVALUATION
Fundamental of public health program development, implementation and evaluation. Basic processes, approaches and interventions that identify and address the major health-related needs and concerns of populations. Pre: Junior Standing. (3H,3C)

4044: PUBLIC HEALTH POLICY AND ADMINISTRATION
Evolution and analysis of public health policy in the United States. Public health and care systems. Administrative concepts central to public health such as human resources, strategic planning, controlling, directing, leadership and health law. Junior Standing. (3H,3C)

4054: CONCEPTS IN ONE HEALTH
One Health refers to the dynamic interdependence of human, animal and environmental health and provides an important perspective in examining health problems. Theoretical foundations of One Health, methods for assessing animal- human linkages, policies and practices related to One Health and capacity building and public engagement. Junior Standing. (3H,3C)

4064: MODELING INFECTIOUS DISEASES
Mathematical modeling of infectious diseases; simple epidemic models, risk structure and modeling risk structure, multi-pathogen models, multi-host models, temporal seasonal models, spatial models, stochastic dynamics and modeling for public health policy. Pre: Junior Standing. (3H,3C)

4074: PRACTICUM IN PUBLIC HEALTH
Public health theories and concepts in a work setting; comprehensive, structured experience requires student to demonstrate professional competencies while working closely with a supervisor in a public health practice setting. Pass/Fail Only. Pre: Senior Standing. Pass/Fail only. (3H,3C)

4094 (APS 4094) (SOC 4094): APPALACHIAN COMMUNITY RESEARCH
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Agricultural and Applied Economics

Head: Matthew T. Holt
Professors: J.R. Alwang, D.J. Bosch, K.J. Boyle, R. Crowder, G. C. Davis, M.J. Ellerbrock, R.H. Lytton, A. Marathe, M. A. Marchant, B.F. Mills, K. Moeltner, G. W. Norton, D. Orden, J. Pease, and K. Stephenson
Associate Professors: J. Cadot, S. Chen, J.H. Grant, and O. Isengildina-Massa
Assistant Professors: J. Bovay, C. Emlinger, J. Friedel, C. Holmes, C. Larochelle, K.L. Morgan, T.P. Mountain, C.L. Neill, A.F. Ramsey, S. Stewart, and W. Zhang
Instructors: J. Broadwell, K. White, and W.A. White
Undergraduate Director and Career Advisor: M.J. Ellerbrock

Web: **http://www.aaec.vt.edu**

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for

degree requirements.

Major Options

- B.S. in Agribusiness w/ Agribusiness Management Option (AGBM)
- B.S. in Applied Economic Management w/ Environmental Economics, Management, and Policy Option (EEMP)
- B.S. in Applied Economic Management w/ International Trade and Development Option (ITD)
- B.S. in Applied Economic Management w/ Community Economic Development Option (CED)
- B.S. in Agribusiness w/ Veterinary Business Management Option (VBMG)
- B.S. in Applied Economic Management w/ Financial Planning Option (FNPN) Last Degree to be awarded in 2019.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (AAEC)

1005,1006: ECONOMICS OF THE FOOD AND FIBER SYSTEM
1005: How the individual economic actor makes rational choices as: consumer, producer, firm/farm, saver, investor, employee, employer, manager, trader. Economic principles that underlie exchange in business, government and household transactions. Utility maximization in the U.S. and global food and fiber system under conditions of scarcity. Evaluation of policy issues important to society. 1006: Overview of economic systems: capitalism versus communism, socialism, feudalism, mercantilism. Interrelationships of U.S. economic fiscal and monetary institutions and policies regarding agricultural productivity, business vitality, sustainable development, and human capital formation. Affordability, safety and security of food and fiber, cultural dynamics, consumer welfare, industrial profitability, natural resources conservation, rural economic infrastructure, international trade, and social justice. (3H,3C)

1264: PEACE ECONOMICS
Introduction to economic impediments and solutions in the pursuit of world peace, including various perspectives on defining peace, short-term humanitarian conflict over natural resources, ethics in regional and global development, and actual poverty reduction programs. (3H,3C)

2104: PERSONAL FINANCIAL PLANNING
Survey of fundamental personal financial planning needs and decisions of young professionals. Introduction to the personal financial planning needs that special household circumstances or non-traditional household situations may precipitate. Application of cash, credit, and debt management principles to household scenarios. Completion of federal income tax forms for individuals. Managing the household's risk exposure. Introduction to investment decisions, particularly related to retirement accounts. Overview of basic estate planning tools and principles. Discussion of the ethical issues related to financial products and decisions. (3H,3C)

2424: COOPERATIVES AND THEIR IMPACT ON THE HUMAN CONDITION
An assessment of the member-owned cooperative organizational structure, including the founding Rochdale Principles (circa 1842) and how these principles and ethics are still prevalent in modern-day cooperatives. Emphasis will be on both agricultural (supply, marketing, service) and non-agricultural (employee-owned, rural electric, housing, child care, health care, crafts, credit unions) cooperatives, with special attention to the impacts on the human condition. (3H,3C)

2434: FOUNDATIONS OF AGRIBUSINESS
Introduction to the primary management tools as they relate to farm production enterprises and agribusinesses. Principles and concepts of preparing farm and agribusiness financial statements and their analysis. Application of budgeting and risk management. Pre: 1005. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: AGRICULTURAL PRODUCTION AND CONSUMPTION ECONOMICS
The economic principles of production. Applications to decision-making and the allocation of resources for the agricultural firm. Consumer behavior and demand for agricultural products. Pre: 1005, MATH 1025 or MATH 1225. (3H,3C)

3014: ANALYTICAL METHODS IN APPLIED ECONOMICS
Quantitative methods used in applied empirical economic analysis including simple and multiple regression, estimation and application of elasticity, decision analysis, economic simulations, linear programming, and risk analysis. Analysis using spreadsheets stressed. Pre: STAT 3005 or BIT 2405 or STAT 3615. (3H,3C)

3015-3016: INTERNSHIP IN AGRICULTURAL AND APPLIED ECONOMICS
Preparation for, and follow-up to, a practical experience in a selected agricultural, resource, or governmental enterprise, which takes place under the direct supervision of an owner, manager, or supervisor. 3015: offers the student a broad management horizon on understanding the value and the process of setting goals and objectives, and provides methods for evaluating one's abilities, interests, and desires for making career-path choices. 3016: provides a forum for students to share work experiences, discuss human resource issues, and apply the problem solving process to a problem or concern witnessed during the internship. (1H,1C)

3024: MONETARY AND GLOBAL ISSUES IN APPLIED ECONOMICS
Economics of an open economy and its impact on agricultural and natural resource markets. History of the monetary system, national accounts, balance of payments, fiscal and monetary policy, foreign exchange determinants, trade deficits, international finance, globalization and economic growth. Linkages to agricultural policy and commodity markets stressed. Pre: 1005, 1006. (3H,3C)

3204: INTERNATIONAL AGRICULTURAL DEVELOPMENT AND TRADE
Examination of the role of agriculture in less developed countries and how that role is affected by public policies. Dimensions of world food, population, and income problems; theories of economic development and the role of agriculture; traditional agricultural systems and their evolution; agricultural modernization strategies; interactions among natural resources, biofuels, food prices, and sustainable agriculture; the impacts of international trade and aid; and the effects of international development on U.S. agriculture. Pre: 1005 or ECON 2005. (3H,3C)

3314: ENVIRONMENTAL LAW
Principles of law involved in environmental issues, survey of environmental litigation, legislation and administrative rulings. Law topics include natural resources, water pollution, private land use, air pollution, toxic substance, food, drug, pesticides, and biotechnology. (3H,3C)

3324: ENVIRONMENT AND SUSTAINABLE DEVELOPMENT ECONOMICS
Sustainable development through an exploration of hard and soft green schools of thought. Hard Green Strategies reliance on markets, technology, property rights, human ingenuity to increase production efficiency versus Soft Green Strategies-adoption of simpler lifestyles, government subsidies, natural design of buildings (biomimicry), and urban infrastructure to locate public transportation hubs nearest to densely populated neighborhoods to decrease consumption of natural resources. Connecting the influence of place in personal and group identity. Interdisciplinary examination of environmental justice among poor and minority U.S. communities. Social equity distribution of the economic costs and benefits of natural resources management policies. Roles of property rights, economic incentives, religious values, and political power in determining local communities ' capacity to control their environmental destiny. Pre: 1005 or 1006 or ECON 2005. (3H,3C)

3454 (MGT 3454): SMALL BUSINESS MANAGEMENT AND ENTREPRENEURSHIP
Characteristics of small business and entrepreneurs, and their economic importance. Development and operation of a small business, including concepts and principles such as franchising, business plans, capital acquisition, venture capital, financial and administrative control, marketing, human resource and operations management. Taxation, legal, insurance and ethics in small business. Pre: 2434 or ACIS 2115 or MGT 3064. (3H,3C)

3504: MARKETING AGRICULTURAL PRODUCTS
Structure of the agricultural marketing system with emphasis on factors determining farm level prices. Emphasis on how markets coordinate consumer desires and producer costs through marketing channels. Impact of market structure, grades, information, product form, and advertising on farm prices. International trade impacts on producers, consumers, agribusiness, and government. Pre: 1005. (3H,3C)

3514: AGRICULTURAL FUTURES AND OPTIONS
The role of agricultural futures and options in risk management strategies for producers and agribusiness firms and in the price discovery process. Fundamental supply-demand and technical analysis of the markets and pricing processes. Development and applications of effective price risk management strategies. Pre: 1005, 1006, 2434. (3H,3C)

3604: AGRICULTURAL LAW
Legal problems of farm and agribusiness management. Practical application of principles of contracts, negligence, debt instruments and commercial transactions of the farm and agribusiness organization. Selected state and federal laws regulating the farm and agribusiness sector; basic animal laws including state and federal regulation of agricultural sector. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4135 (ECON 4135): INTERNATIONAL ECONOMICS
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). Pre: ECON 3104 or ECON 2025H or AAEC 3004. (3H,3C)

4204: FOOD AND AGRICULTURAL POLICY
Examination of the role of agriculture in developed economies and how agriculture is affected by policy decisions in the public sector. Emphasis will be placed on the economic impacts of policies on the producers and consumers of agricultural products: price supports, food stamps, tariffs and quotas. Pre: 1005, 1006. (3H,3C)

4314: ENVIRONMENTAL ECONOMIC ANALYSIS AND MANAGEMENT
Quantitative methods and computer-aided tools used in the economic analysis of environmental/natural resource issues. Economic concepts and analytical tools will be applied to realistic, problem-solving situations. Topics include cost effectiveness analysis, benefit-cost analysis, economic simulations, and statistical analysis. Pre: 3324 or ECON 4014 or FOR 3424 or FREC 3424. (3H,3C)

4324: RURAL AND REGIONAL DEVELOPMENT POLICY
Description of rural areas, their economic structure, and conditions for broad-based economic development. Emphasis on the role of markets in the development process. Introduction to tools to evaluate policies and programs, identify distributional impacts, identify appropriateness for long-term sustainable development, and analyze tradeoffs between policy goals. Alternatives to public financing in rural areas. Pre: 1005, 3004. (3H,3C)

4334: APPLICATIONS RURAL DEVELOPMENT
Evaluation of policy alternatives and programs for the development of rural areas. Intensive use of analytical techniques, including spreadsheet analysis of trends and changes over time, shift-share analysis of economic change, creation of indices of distribution and poverty for rural areas, creation and use of economic base

multipliers, construction, use and interpretation of input-output models. Pre: 1005, 3004. Co: 4324. (1H,1C)

4344: SUSTAINABLE DEVELOPMENT ECONOMICS
Sustainable development concepts are critically explored particular emphasis on implications for domestic and international sustainable development agriculture and for economic development. Students investigate case studies illustrating problems of sustainable development and potential policy solutions. Pre: (3324 or 3004 or ECON 4014). (3H,3C)

4404: AGRICULTURAL MANAGEMENT AND PROBLEM-SOLVING
Capstone course for students interested in agribusiness management. Application of concepts, tools, and principles including management, finance, marketing, economic theory, and quantitative methods to applied agricultural decisions. Application of knowledge on selected agricultural projects that enhance team-building, written, and oral communication skills. Senior Standing required. Pre: 3454. (3H,3C)

4414: APPLIED ECONOMIC PROBLEM-SOLVING
Application of economic training and skillsets to real-world needs identified by clientele. Team problem-solving of financial, marketing, production, legal and regulatory, and human resources issues unique to the agriculture sector. Facilitated experiential learning environment focused on student-motivated solutions to economic risk management. This course may be repeated once. Pre: 1005. (3H,3C)

4424: AG FINANCIAL MANAGEMENT
Principles and concepts of preparing agricultural financial statements. Analysis of these statements following professional farm financial guidelines. Economic concepts applied to management of agricultural enterprises. Leasing, purchasing, borrowing, and lending decisions in agriculture. Agricultural applications of budget, risk management and mitigation, and loan structuring. Pre: 1005, 2434, FIN 3104. (3H,3C)

4434: COMMODITY INVESTING BY STUDENTS
Students make real world investment decisions in agricultural and energy commodities, execute trades, evaluate their performance and report to the VT Foundation. This student-run organization provides leadership opportunities as well as collaboration and networking experiences. Restricted to COINS members. May be repeated with different content up to 8 credit hours. This course is Pass/Fail. Pass/Fail only. Pre: 3514 or 4504 or FIN 4294. (2H,2C)

4464 (FREC 4464) (WATR 4464): WATER RESOURCES POLICY & ECONOMICS
Economic concepts to understand public and private decisions about water use. Current water policies and law. Analytical tools to evaluate policies and address management challenges. Water markets, climate change, and environmental flows. Pre: 1005. (3H,3C)

4504: AGRICULTURAL PRICE AND MARKET ANALYSIS
Estimation of agricultural supply, demand, and price relationships. Determination of market potential for new products. Students identify problem, collect data, estimate statistical relationship(s), interpret results, and write research report. Use of probability distribution in marketing strategy development. Pre: 3004, STAT 3005, STAT 3615, BIT 2405. (3H,3C)

4514: ADVANCED AGRIBUSINESS MARKETING
Applying concepts, principles, and analytical tools in developing a marketing plan for an existing or new agricultural product or service. Students will define the market, perform competitive marketing analysis, outline market assumptions and objectives, and perform a three-year financial evaluation of the action plan. Course can be repeated once. Co: 3504 or 3004. Variable credit course. Pre: 2434, 3504.

4754: REAL ESTATE LAW
The law of real property, legal framework, law of estates in land, conveyancing, landlord-tenant and non-possessory interest in real property. Zoning, easements, restrictive covenants. Mortgages, deeds of trust, and taxation of real estate. Junior standing required. (3H,3C)

4764: REAL ESTATE APPRAISAL
Application of economic principles to the valuation and appraisal of property. Income, cost and comparable approach to value. Rural property, commercial, residential and transitional will be evaluated. Ethical and professional requirements. Variable lab credit available to meet Real Estate licensing requirements. (Course

credits may vary from 3 to 5 hours.) Junior standing required. Variable credit course.

4804 (STAT 4804): ELEMENTARY ECONOMETRICS
Economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations. Pre: 1006, (STAT 3005 or STAT 3604). (3H,3C)

4814: FOOD AND HEALTH ECONOMICS
Microeconomics of food, nutrition, and health. Overview of nutrition, nutrition recommendations, and implications for economics based decisions. Individual and household food consumption and health production models. Farm to consumer market linkage models with nutrition and health implications Effectiveness of food and nutrition interventions and policies. Cost-benefit and cost-effectiveness analysis of health interventions. Pre: Senior Standing required. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Accounting and Information Systems

Head: John J. Maher
KPMG Professor: R. Barkhi
R. B. Pamplin Professor of Accounting and Information Systems: F. Belanger
John F. Carroll, Jr. Professor of Accounting and Information Systems: J. J. Maher
Thomas M. Wells and Kathy Dargo Professor: S. Bhattacharjee
Professors: S.D. Sheetz
Associate Professors: L.L. Lisic, D.P. Tegarden, and L.G. Wallace
Assistant Professors: A.A. Acito, M.A. Cobabe, R.H. Davidson, M.J. Erickson, M.K. Harding, S.M. Hillison, J. Huang, E.S. Johnson, M.R. Lowry, S.E. Stein, L. Tan, M.D. Vance, and M.C. Wolfe
Collegiate Assistant Professors: C.M. Easterwood and D.P.Garner
Associate Professor of Practice: N.A. Rogers
Assistant Professor of Practice: L.A. Almond and E.A. Martin
Instructors: J.M. Lacoste, E.A. Martin, J.P. Sharp, and J.L. Shortt
Career Advisor: J.J. Maher (231-6591)

Web: **www.acis.pamplin.vt.edu**

Our Mission

The Department of Accounting and Information Systems in the Pamplin College of Business strives for excellence in fulfilling the three missions of a comprehensive land grant university by:

- Improving the accounting and information systems professions by conducting quality research and disseminating the results;
- Providing a world class accounting and information systems education to our students; and
- Delivering outreach services to accounting and information systems professionals and educators.

The department seeks to fulfill the teaching mission through programs which include:

Undergraduate Programs, where we seek to

- *Prepare students to enter the accounting and information systems professions with the skills and knowledge of business, information systems, and accounting concepts and practices.*

Masters of Accounting and Information Systems, where we seek to

- *Prepare students for professional careers with specializations in taxation, information systems, audit, and financial services.*

Ph.D. Program in Business with a major in Accounting and Information Systems, where we seek to

- *Prepare students for academic careers in research and teaching.*

The Department of Accounting and Information Systems prepares students to become professionals in their chosen area of accounting and information systems. Faculty members in the department have chosen to specialize in selected areas of accounting or information systems and they teach and conduct research in these areas. All faculty members at the professorial ranks have Ph.D.s in accounting or information systems appropriate to the courses they teach, and many have professional certification in their areas of specialization. This faculty is committed to the education of accounting and information systems professionals who will be active participants in this information age, with increasing demand for data analytics skills.

The department's undergraduate program offers two options: Accounting (ACCT) and Information Systems Audit (ISA). These options are designed to allow students to specialize in their area of interest.

Completion of the selected option prepares the student for entry level positions as professional accountants or information systems professionals who work in professional service firms, industrial companies, governmental entities, or to continue their education in graduate school. The job titles vary greatly and include auditor, information systems auditor, management accountant, tax preparer, systems consultant, systems analyst, controller, financial data analytics specialist, and cost analyst. The demand for our graduates has been strong throughout the department's history, and that demand is continuing.

Many graduates of our department desire to gain certification in their selected area of specialization. The Certified Public Accountant (CPA) is the best known of these certifications. Students taking the CPA exam in Virginia have to meet a 120-hour baccalaureate or higher degree requirement in order to sit for the CPA exam, but must have 150 credit hours to be certified. The requirements for other states vary; however, most require students to meet the 150-hour educational requirement to be licensed. Students should discuss with their advisor the several options Virginia Tech provides for meeting this requirement at both the undergraduate and graduate level. In addition to the CPA exam, graduates of our programs sit for the Certificate in Management Accounting (CMA) exam, the Certified Internal Auditor (CIA) exam, the Certified Information Systems Auditor (CISA) exam, and others. Students planning to take one of these exams are advised to talk to their department's faculty during their junior year so that they may select the electives appropriate for the selected exam.

The department encourages its students to gain "real world" **experience** prior to graduation through an internship or by participating in the Cooperative Education Program. More information about these programs is available either from the department's faculty or Career Services. The department supports winter internships for seniors who enroll in the 152-hour program.

The department also encourages **interaction with accounting and information systems professionals** by sponsoring three student organizations: Accounting Society; National Association of Black Accountants; and Beta Alpha Psi, the national honorary and professional society dedicated to the advancement of the accounting profession. These organizations and other campus groups provide multiple opportunities for developing leadership skills and interacting with accounting and information systems professionals.

The department encourages students to gain a **global perspective** of business through modules on international issues in our courses, by participation in the college's International Business Minor and/or by participating in one or more of the college's study abroad programs. Our goal is to encourage our students to become well-rounded professionals who will become leaders in their chosen careers.

Lastly, many of the department's over 7,000 alumni have generously contributed to a variety of scholarships for accounting and information systems majors. Each year the department awards over $300,000 in scholarships to our students.

Course Requirements

Students graduating from the Department of Accounting and Information Systems must have a minimum quality credit average (GPA) of 2.00 in upper-division (3000 and 4000 level) accounting and information systems courses (the in-major GPA) as well as an overall GPA of 2.00 for all courses taken at Virginia Tech.

During their sophomore year, students must select one of the two options in the department: Accounting (ACCT) and Information Systems Audit (ISA). These options are more fully described below.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Accounting Option (ACCT)

The Accounting option provides basic education for careers in public accounting, internal auditing, large and small corporations (controller's staff), governments (federal, state, and local) and their agencies, and nonprofit organizations. Graduates from this option are prepared to become CMAs, CIA, CPAs, and all of the other common professional accounting designations. Many of the students who select this option will continue into the Master of Accounting and Information Systems program.

Information Systems Audit Option (ISA)

The IS Audit option is designed to prepare students for careers as information systems auditors and information systems professionals in the areas of enterprise risk assurance services, computer risk management services, and other systems assurance services. These positions are available in organizations from all sectors of business: industry, professional service firms, consulting firms, government, and nonprofit organizations. This track prepares graduates to sit for the CIA, CPA, CISA, or other professional designations.

Undergraduate Course Descriptions (ACIS)

1004: ACCOUNTING FOUNDATIONS
Fundamentals of accounting, the language of business, including what accounting information is, how it is developed, how it is used and what it means. Financial Accounting including the application of accounting principles for real world, complex business transactions to classify these transactions, reflect their economic value, produce basic financial statements, evaluate financial position and make fundamental interpretations. Managerial Accounting including cost behaviors, budgeting and other management reporting to assist in internal decision making and performance analysis. Attention to accountants' codes of ethics applied throughout. Emphasis placed on non-Business majors becoming informed users of accounting information. No credit will be given for ACIS 1004 if taken with or after ACIS 2115 or ACIS 2116. (3H,3C)

1504: INTRODUCTION TO BUSINESS ANALYTICS & BUSINESS INTELLIGENCE
Introduction to Business Information Systems with emphasis on the role of software applications as a tool to develop Business Intelligence to improve decision making. Design and development of spreadsheet and database solutions employing analytical techniques on large data sets to produce quality information. Ethical considerations of information management. (3H,3C)

2115-2116: PRINCIPLES OF ACCOUNTING
Comprehensive presentation of basic principles of financial and managerial accounting including origin, purpose, and effect with emphasis on application. Sophomore standing required. A grade of C- or better required in prerequisite (2115 for 2116). (3H,3C)

2504: PERSONAL COMPUTERS IN BUSINESS
Focuses on the design and implementation of spreadsheet projects that support advanced decision-making and problem-solving techniques for professionals and individual business users. An introduction to programming logic is included to allow students to augment and automate spreadsheets. Students enrolling in this course are expected to be familiar with basic spreadsheet skills including spreadsheet navigation, managing multiple worksheets, formatting, formulas, and cell references. Pre: 1504. Co: 2115. (3H,3C)

2954: BUSINESS STUDY ABROAD
This course provides students with an international business experience. The course examines the accounting and information systems issues that impact the multinational business. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. Content will vary between semesters. Pre: Instructor's consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent. May be repeated for a maximum of 9 credit hours. Variable credit course.

3115-3116: INTERMEDIATE FINANCIAL ACCOUNTING
In-depth analysis of basic concepts of external financial reporting. Includes transaction analysis and preparation of financial statements. Course credit will not be awarded for both ACIS 3115 and ACIS 4194. Pre: 2115 for 3115; 3115 for 3116. Co: 2504 for 3115. (3H,3C)

3314: TAX IMPACT ON DECISIONS
An analysis of the impact of taxation on business and investment decisions, and the importance of effective tax planning. The course develops a conceptual framework that integrates tax and non-tax factors into decision models. Topics to be covered include basic tax planning strategies, tax policy, an overview of basic tax concepts and terminology, implicit taxes and tax clientele theory, choosing the optimal organizational form, multilateral tax planning in contexts such as executive compensation, and multi-jurisdictional tax issues. Pre: 3115. (3H,3C)

3504: ACCOUNTING SYSTEMS AND CONTROLS
Examines system design concepts and methods including an understanding of basic control structures. Covers specific accounting cycles and computerized transaction processing systems. Analyzes controls for manual and computerized systems including database systems. Pre: 2115. Co: 2504, 2116. (3H,3C)

3564: MANAGEMENT INFORMATION SYSTEMS
An overview of management information systems. Topics include the organizational foundations of information systems; the technical foundations of information systems; the approaches to building information systems; and the management of contemporary information systems. Pre: 1504, 2115, 2116. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4024: INFORMATION SYSTEMS AUDIT AND CONTROL
An introduction to the fundamentals of information systems auditing. Emphasis on information systems controls, types of information systems audits, and concepts and techniques used in information systems audits. Exposure to risk assessment and professional standards in the field of information systems auditing. Pre: 3504, 4414. (3H,3C)

4114: ADVANCED FINANCIAL ACCOUNTING
A continuation of a detailed analysis of the concepts of external financial reporting begun in 3115 and 3116. Includes transaction analysis and preparation of financial statements. Pre: 3116. (3H,3C)

4124: GOVERNMENTAL AND NONPROFIT ACCOUNTING
An analysis of the environment and characteristics of government and nonprofit organizations, and an in-depth study of basic concepts and standards of financial reporting for such entities. Pre: 3115. (3H,3C)

4194: ANALYSIS OF FINANCIAL STATEMENTS
Provide theoretical background and tools necessary to analyze financial statements from the perspective of making valuation and investment decisions. The focus of the course is on the use of accounting information in making these decisions. Course credit will not be awarded for both ACIS 3115 and ACIS 4194. Pre: FIN 3134. (3H,3C)

4214: COST PLANNING AND CONTROL
The purpose of this course is to help the student develop an understanding of the role of accounting in the management process, an understanding of cost accounting systems, an understanding of cost behavior, an understanding of alternative accounting systems, and the usefulness of costs involved in

non-routine decision-making. Pre: 2116, 2504, BIT 2406. (3H,3C)

4344: TAX FOR FINANCIAL PLANNERS
Overviews income tax concepts relevant to financial planning for individuals who are investors, employees, and business owners. Topics include income tax fundamentals for individuals, taxation of the sale of property, taxation of business entities, taxation of trusts, and overview of the federal transfer tax on estates and gifts. Duplicates some material in ACIS 4314. Course credit will not be awarded for both ACIS 4314 and ACIS 4344. Pre: FIN 3104. (3H,3C)

4414: FINANCIAL STATEMENT AUDITING
Study of external financial statement auditing, professional code of conduct, audit evidence considerations, internal control, fraud, and transaction cycles, and audit reporting. Pre: 3115. Co: 3504. (3H,3C)

4444: FORENSIC ACCOUNTING
This course provides students experience in forensic accounting, commonly used computer forensic software, forensic techniques, litigation support, fraud risk management, fraud investigation, and the related audit tools. Pre: 3115. Co: 4414, 3504. (3H,3C)

4514: DATABASE MANAGEMENT SYSTEMS
Introduction to database management systems and their use in business. Topics covered include data modeling, normalization, SQL, transaction management and concurrency control, security issues, physical data organization, query optimization, hierarchical queries, distributed database management systems, object-oriented databases, client/server databases, multidimensional databases, data mining, data warehousing, and database administration. (3H,3C)

4554 (BIT 4554): NETWORKS AND TELECOMMUNICATIONS IN BUSINESS
This course provides an in-depth introduction to computer networks and data communications in business. Topics include mechanisms for reliable data transfer, local and wide area network topologies and technologies, and a comprehensive treatment of internetworking. The benefits, costs, and security issues related to using computer networks are discussed, along with network design issues, and methodologies for network applications. One semester of college-level programming experience required. Pre: 3504 or BIT 3424. (3H,3C)

4654: ACCOUNTING ANALYTICS
Design and development of accounting systems using relational database management tools. Extraction and analysis of accounting data using queries, analytics, and visualization techniques. Application of accounting data analytics concepts using commercially available tools such as audit management software and current visualization tools. Proper preparation of data and use of analytics algorithms and visualization techniques to inform decision making. Pre: 2504, 3504, 3115. (3H,3C)

4684: INFORMATION SYSTEMS SECURITY AND ASSURANCE
An examination of the concepts, technologies, and applications of security and assurance in information systems. Topics include the security threats against information systems; tools used by intruders; computing platforms and security; encryption; securing the transaction and the server; audit tools to detect intrusions; responses to attacks; legal, ethical and international issues; and the future of information systems security and assurance. Co: ACIS 4554 or BIT 4554. (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Apparel, Housing, and Resource Management

Head: Julia O. Beamish
Professors: J.O. Beamish, L.R. Gaskill, D.H. Kincade, and K. Parrott
Associate Professors: H.I. Chen-Yu, P.J. Fisher, E. Hwang, I.E. Leech, and D.C. Read
Assistant Professors: E.Z. Hopkins, J. E. Lee, and E. Shin
Instructors: C. Jones and P. Quesenberry

Web: **www.ahrm.vt.edu**

Overview

The mission of the Department of Apparel, Housing, and Resource Management is to improve quality of life for individuals, families, and the broader community by creating and extending knowledge in apparel, housing, and resource management. We apply business, consumer, and design perspectives to teaching and learning, research, and outreach.

The AHRM Department includes five majors Consumer Studies, Family and Consumer Sciences, Fashion Merchandising and Design, Property Management, and Residential Environments and Design.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Consumer Studies Major

Career Advisor: I. Leech

The Consumer Studies major prepares students to enter a variety of careers in the public and private sectors. Central to these careers is the ability to analyze issues and problems from the perspectives of consumers, business, and government. Students learn to reasonably advocate consumer interests and to help consumers improve their well-being. They develop fundamental skills that are used to resolve problems faced by consumers in the market place and the work place.

Graduates enter careers related to consumer affairs, marketing and sales, business management, and human resources. Required courses build a thorough understanding of households in the dual roles of producers and consumers that function within an international economic marketplace affected by government policy and regulation. Students study current events to track changing conditions and public policy. Additional courses develop skills for effectively processing and conveying information. A choice of controlled electives enables a student to tailor study to consumer products and promotion or consumer financial services, and counseling.

Consumer Studies students are provided a variety of learning experiences on- and off-campus. Through involvement with student professional associations, as well as relevant state and national organizations, students can develop leadership and organizational skills and network with active professionals. There are opportunities to relate classroom learning to the "real world" with projects and visits with industry, legislators, and regulators. An individualized study experience, typically an internship related to personal career interests, is required.

Family and Consumer Sciences Major

Career Advisor: J. Beamish

Family and Consumer Sciences (FCS) is a comprehensive study of the relationship between individuals, families, and communities, and the environment in which they live. The FCS major prepares graduates to help people make informed decisions about their well-being, their relationships, and their resources in order to achieve an optimal quality of life. FCS combines courses in consumer studies, family finance, housing, residential technologies, clothing, human development, nutrition, and health. This multidisciplinary program also encourages students to focus in depth on these topics, through the selection of a broad list of controlled electives, as well as an industry internship.

The FCS curriculum incorporates the content courses needed to achieve licensing to teach Family and Consumer Sciences at the secondary level in Virginia. To become licensed to teach through Virginia

Tech, graduates of the FCS program should pursue a Master of Sciences in Education degree with a major in Career and Technical Education. Students who study Family and Consumer Sciences could also choose to work in other community educational settings, such as the Cooperative Extension Service, human resource departments, or nonprofits. They could also work with industries to provide programs in family and individual well-being or in media that provide information about families and consumer goods to the public.

Fashion Merchandising and Design Major

Career Advisor: D. Kincade

Apparel fashion is an exciting and competitive field where designers, product developers, manufacturers and retailers create and merchandise products and services for target customers. The Fashion Merchandising and Design major prepares students for diverse career opportunities available to graduates of the program. Students may find employment with apparel or textile manufacturers or with a wide variety of retailers and fashion media, including magazines and social media websites. Products in apparel fashion range from fast fashion and haute couture to special-use apparel for athletes and extreme sports to accessories and shoes. Graduates from the FMD major may be employed in the areas of product development and/or merchandising. Positions in merchandising include: assistant buyer, buyer, fashion journalist, internet merchant, merchandise manager, showroom manager, store manager, and visual merchandiser. Positions in design and product development include: creative designer, technical designer, private label manager, sourcing analyst, and production manager.

The FMD curriculum is structured to build students' knowledge and skills in the design, development, production, marketing, sale, and use of apparel and other textile products. Individuals employed in today's fashion world need to understand both product design and development and merchandising management. In addition, students learn details about the business and economics of the textile and apparel industry and the cultural and historic aspects of apparel fashion. Supporting courses in accounting or statistics, management, and marketing enhance career preparation.

Many courses in the FMD major promote hands-on learning so that students gain industry type experiences in product development, computer-aided design, textile and apparel evaluation, merchandise planning, promotion, and consumer patronage behavior. Through coursework, internships, study tours, student organizations, and interaction with industry experts, students become prepared to enter the dynamic apparel fashion field.

Property Management Major

Career Advisor: K. Avery

Property management offers a fast-growing career encompassing positions in luxury and affordable apartment developments, senior living communities, mixed-use, and office and retail properties. Hundreds of management positions are available each year, and graduates of Virginia Tech's program are in great demand because they are equipped with skills that address the complexities of managing multimillion-dollar investments. Employment is available in various aspects of the industry including management, operations, marketing, human resources, training, development, and acquisitions.

The property management major offers a wide-ranging program of study that includes specific courses in property management, as well as supporting courses in housing, business, and real estate. All students complete at least one internship that is typically a paid internship with housing provided. The internships give students an opportunity to gain real-world experience, make valuable career contacts, and explore different aspects of property management. Property management's very active advisory board visits campus twice yearly, and many also attend the property management career fair held on campus each March. Board members act as mentors and provide financial support for field trips, professional development, and scholarships. Property management seniors take the National Apartment Association's Certified Apartment Manager exam. Graduating with this credential places new employees a year or more ahead of other entry-level peers.

Residential Environments and Design Major

Career Advisor: K. Parrott

The Residential Environments and Design (RED) major focuses on the planning, design, and marketing of residential environments. Required courses emphasize design, human, social, and business factors, including current issues and practices, which influence the environment of housing. The diversity of the population with differing needs, the range of available products, the growth of regulation, the increased concern for health and safety, and the rapid changes in technology are among the factors that lead to a very complex marketplace in the residential industry.

There are many career opportunities for graduates of the RED major, which provide employment as well as business opportunities. Employment opportunities include certified kitchen and bath designers, manufacturing and sales of residential products, residential construction, home furnishings, appliances, and related industries. The future looks bright for those students who choose careers in the residential design industry. A number of trend and demographic indicators suggest that people will continue to spend money on their homes and need products and services from experts. There will be a strong, on-going need in the residential industry for well-educated professionals with specialized knowledge in design and the ability to think and solve complex problems.

The RED major's program in kitchen and bath design is accredited by the National Kitchen and Bath Association, and interested students can prepare to sit for the first level design certification examination. Students in the major are mentored by industry members of the Residential Environments and Design Industry Board. Classroom learning is expanded through field trips, guest speakers, community clients, internships, competitions, and other special projects.

Undergraduate Course Descriptions (AHRM)

1014: DESIGN AND ART FOR CONSUMERS
Overview of art and design principles and elements with a focus on their application in the creation and promotion of apparel, housing, and residential technology products for diverse consumers. Review of historical art and design trends and theories in relation to these products. Interpretative strategies and methodologies in visual art and design. Exploration of the design process, including examinations of human factors and user needs. (3H,3C)

1104: INTRODUCTION TO AHRM AND STUDENT RESOURCES
Introduction to the Department of Apparel, Housing, and Resource Management (AHRM), majors and curriculum requirements. Introduces students to experiential learning opportunities, undergraduate research, and career opportunities. Exploration of programs and services to enhance awareness of opportunities and support systems available for student success. (1H,1C)

2014: DESIGN FOR CONSUMERS STUDIO
Exploration and application of design principles and elements in two-dimensional and three-dimensional designs that support the development and promotion of products for diverse consumers, including apparel, housing, residential technologies. Application of skills, tools, and methods to the creation of design. Utilization of the design process to develop plans for consumer products for diverse users. Design Lab/Studio. Pre: 1014. (5L,3C)

2404: CONSUMER RIGHTS
Role of consumers in society and in national and international markets. Consumer rights, responsibilities, policies, regulations and redress. Consumer decision making and planned buying. Current consumer issues such as: product safety, food, health care, housing, environmental impact, banking, credit and insurance from an intercultural perspective. (3H,3C)

3464 (APS 3464) (GEOG 3464) (HD 3464) (HUM 3464) (SOC 3464) (UAP 3464): APPALACHIAN COMMUNITIES

The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

4984: SPECIAL STUDY
Variable credit course.

Undergraduate Course Descriptions (CONS)

2304: CONSUMER AND FAMILY FINANCES
Overview of consumer and family finances, including budgeting, goal setting, cash management, credit, insurance, taxes, housing, investment alternatives, and retirement plans. Fundamental tools for financial decision making through the coverage of time value of money, calculations for consumer loans, and tools for financial decisions across the lifecycle. Explore ethical issues surrounding financial decisions. (3H,3C)

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPDENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3404: CONSUMER EDUCATION STRATEGIES
Analysis of the role of effective consumer education strategies in consumer decision-making. Planning, developing, testing, and evaluating consumer education programs using a variety of strategies, including social marketing, for selected community partners and operating the Consumer Education Laboratory. Pre: AHRM 2404, (AHRM 2304 or CONS 2304). (2H,2L,3C)

3504: RESOURCE MANAGEMENT FOR INDIVIDUALS & FAMILIES
Introduction to resource management concepts and theories with application to personal and family life goals. Discussion of values, goals, decision making, planning, and communication in relation to the management process. Application of the management process to the use of resources, time, finances, stress, and the environment. Pre: AHRM 2304 or CONS 2304 or AAEC 2104 or FIN 2114. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4304: ADVANCED CONSUMER FAMILY FINANCES
Advanced financial topics for consumers and families. Identification of employee benefit components including health care, incentive plans, insurance, and retirement. Analysis of consumers' insurance needs. Discussion and comparison of retirement and investment tools used by consumers, including public and private retirement components. Interpretation of research directions and policy influences related to employee benefits, insurance, investments, and retirement saving. Investigation of special topics in retirement. Pre: Senior Standing. Pre: 2304 or AHRM 2304 or AAEC 2104. (3H,3C)

4314: DEBTOR-CREDITOR RELATIONSHIPS
Examination of legal and operational aspects of debtor-creditor relationship from the perspective of businesses and debtors. Overview of the types of credit, access to credit, factors contributing to debt problems, and alternatives available for resolution. Focus on collection processes of federal and state bankruptcy laws and regulations. (3H,3C)

4324: FINANCIAL COUNSELING
Examination of debt and budgeting problems affecting families. Utilizes a problem-solving approach.

Includes financial counseling strategies for coping with financial crises and becoming proactive in family financial management. (3H,3C)

4404: CONSUMER PROTECTION
Analysis of the effectiveness of consumer protection efforts. Examination of government laws, regulations, and agencies at the federal, state, and local levels, as well as the effectiveness of both business and private consumer protection efforts. (3H,3C)

4414: PROFESSIONALISM IN CONSUMER AFFAIRS
Roles, functions and responsibilites of consumer affairs professionals employed in business, government, and non-profit public/consumer interest organizations. Professional advocacy within employing organizations, managing consumer complaint handling systems and major consumer and career issues are analyzed. (3H,3C)

4964: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4964H: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4984H: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (FCS)

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3954: STUDY ABROAD
Variable credit course.

4964: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4964H: FIELD WORK/PRACTICUM

Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4984H: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (FMD)

1204: CLOTHING AND PEOPLE
A personal and societal approach to the study of clothing and its importance in people's lives. Social, psychological, and economic forces that affect clothing behavior of individuals and groups. Fundamentals of clothing and textiles importance to consumers. (3H,3C)

1224: INTRODUCTION TO THE FASHION INDUSTRY
Development, structure and operations of textile and apparel manufacturers, marketers and retailers in the fashion industry and the product types including menswear, womenswear, childrenswear and accessories. Identification of fashion careers and major fashion markets and vendors both domestic and international. Basic processes and principles governing forecasting fashion acceptance, movement and change as influenced by economic, sociological, psychological, political and technological factors. Sources of industry information such as trade journals, industry websites and company publications. (3H,3C)

2034: HISTORY OF COSTUME
A study of costume worn by people in historical and contemporary periods. Coverage of the evolution and development of Western costume. Use of fashion, clothing, and design terminology. Influence of historic costume on contemporary fashion and design. (3H,3C)

2204: INTRODUCTION TO TEXTILES
Structure, properties and basic production of textiles and textile components: natural and manufactured fibers; yarns; woven, knit, nonwoven fabrics; mechanical and chemical finishes; colorants and coloration methods. Influence on performance of apparel and interior textile products. Sophomore standing and one semester (lecture) of university core requirement in Scientific Reasoning and Discovery is required. Co: 2214. (3H,3C)

2214: APPAREL TEXTILES LABORATORY
Identification and characterization of textiles and textile components including: fabrics, finishes and coloration. Influence of these structural parameters on performance of apparel textiles. Co: 2204. (3L,1C)

2224: FASHION PRESENTATION TECHNIQUES
Basic principles and methods for executing fashion illustrations, proportions of the fashion figure, design details, portfolio development, identifying target markets and fabric renderings with consideration toward diverse populations in the global marketplace. Exploration and practice in color with work in pencil, color pencil, pastel, and watercolor. Practice and skill development using a variety of manual and computer tools to illustrate construction details and create technical flats. Emphasis placed on the use of correct industry terminology. Pre: AHRM 1014. (2H,3L,3C)

2264: APPAREL PRODUCT DEVELOPMENT
Study of the pre-production stage of product development in the apparel industry, including planning a line based on market, consumer, and product research, forecasting trends in color, style and materials, developing and selecting designs and styles, and wholesale marketing of a line to retail buyers. Also includes the use of diverse inspiration sources for creating a design, application of computer-aided design to design and style development, and identification of career opportunities and qualifications for professional positions in the industry. Sophomore Standing required. Pre: 1214 or 2224. (2H,2L,3C)

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3104: FASHION RETAILING CONCEPTS
Detailed investigation and analysis of the fundamentals of fashion merchandising concepts emphasizing problem solving at the retail level. Prerequisite: one semester of CLE Area 5 - Quantitative and Symbolic Reasoning required. Pre: Junior Standing. Pre: 1224. (3H,3C)

3204: INTRODUCTION TO TEXTILE EVALUATION
Analysis of the performance properties of fabrics. Importance of evaluation to product development, quality control, and specification of care requirements. Pre: (AHRM 2204 or FMD 2204), (AHRM 2214 or FMD 2214). (2H,3L,3C)

3224: APPAREL PRODUCTION
Application of concepts and principles of basic and intermediate-level apparel patternmaking and construction from the apparel industry perspective to the creation of prototypes, product specifications, and finished products. Students will gain conceptual understanding of simple to complex apparel construction techniques, learn the stitch and seam types and their applications, and develop skill in using a variety of manual and computer tools and equipment for apparel patternmaking and construction. Prerequisite: Sophomore standing. Pre: AHRM 1204 or FMD 1204. (3H,3L,3C)

3234: FIT, PATTERNMAKING, AND DRAPING
Study of apparel product development from the apparel industry point of view using intermediate and advanced techniques and skills. Focus on conceptual understanding and application of garment fit, pattern and product alteration, pattern grading, and marker making priciples and of flat-pattern and manikin-drape techniques used in apparel engineering and product development, along with development of skill in using a variety of related manual and computer tools. Pre: Junior standing required. Pre: AHRM 3224 or FMD 3224. (3H,3C)

3244: SMALL BUSINESS APPAREL RETAIL DEVELOPMENT
Comprehensive study of small business concepts as applied to the textile and apprel retail industry. Analysis of the entrepreneurial mindset and strategies for business entry with emphasis on small business development, including concept and opportunity identification, merchandising and management, operations and control, advertising and promotion, and financial planning for a textile and/or apparel retail business. Pre: (AHRM 2264 or FMD 2264), (AHRM 3104 or FMD 3104). (3H,3C)

3254: GLOBAL APPAREL PRODUCTION AND TRADE
Study of evolution, basic elements, patterns, and implications in developed and developing countries of contemporary global apparel production and trade. Course topics also include key roles of U.S. firms and government agencies in global apparel production and trade, the types and roles of firms that participate in such production and trade, as well as international trade policies and other factors that influence global

apparel production and trade. Pre: Junior Standing required. (3H,3C)

3264: DRAPING
Study and application of basic and advanced draping techniques for patternmaking in the apparel industry, including darts in skirts and bodices, princess lines in bodices, yokes, pleats and gores in skirts, and asymmetrical structures for whole garments; selection of fabrics appropriate for garment styles; evaluation of garment fit, design and construction. Includes students' design and construction of garments suitable for juried design competitions or exhibitions. Design Lab/Studio. Pre: Junior Standing Pre: 2264, 3224. (5L,3C)

3954: STUDY ABROAD
Variable credit course.

4024: PORTFOLIO
The development and production of a professional apparel portfolio in both paper and ePortfolio format. Pre: Senior Standing required; 3234 or permission of the instructor. Pre: 3234 or 3264. (3H,3C)

4124: CLOTHING BEHAVIOR PATTERNS
Study of clothing behavior of individuals in relationship to their needs, values, attitudes, interests, and self-concepts. Overview of principles and theories related to individuals' emotional, mental, and physical activities when obtaining, using, maintaining, and disposing of apparel products so as to satisfy their needs and desires. Application of principles and theories related to clothing behavior to the analysis of consumer and the development of effective merchandising strategies. Pre: (AHRM 3104 or FMD 3104), (PSYC 2004 or PSYC 1004 or SOC 1004). (3H,3C)

4214: ECONOMICS OF THE TEXTILE AND APPAREL INDUSTRY
Study of the various segments of teh textile and apparel industry. Analysis of the market structure and functioning of each segment and of factors currently affecting the industry. Pre: (AHRM 2204 or FMD 2204), (ECON 2006 or ECON 2006H) or (AAEC 1005, AAEC 1006). (3H,3C)

4224: FASHION ANALYSIS AND COMMUNICATION
Analysis of factors influencing fashion change and acceptance. Application of effective promotional activities to trade, national, and retail levels of fashion merchandising. Senior standing required. Pre: (AHRM 2264 or FMD 2264). (3H,3C)

4234: APPAREL QUALITY EVALUATION
Study of quality of ready-to-wear apparel and factors that influence variations in the aesthetic and functional performance of the end product, including consumer perceptions and expectations, manufacturing processes and trends, and the physical components of the end product. Pre: (AHRM 3204 or FMD 3204), (AHRM 3224 or FMD 3224). (3H,3C)

4244: NEW YORK FASHION STUDY TOUR
Integrative study of methods of operating at all levels within the fashion industry. Special emphasis on design, merchandising, and promotional activities. Seminars on campus and at pre-arranged appointments during a five-day stay in New York. AHRM major; Junior standing. Twelve hours of AHRM/FMD courses required. (3H,3C)

4264: MERCHANDISING STRATEGIES
A senior capstone course providing students with experience in synthesizing and using course content learned throughout their apparel program. Includes projects in forecasting, product development and promotions as used in the apparel industry in preparing and positioning products in the market. Pre: 3104. (3H,3C)

4274: INTERNATIONAL SOURCING OF APPAREL
Study of international sourcing of apparel products through a step-by-step simulation of the sourcing process to help students understand the procedures and documents needed to source apparel abroad. Also includes discussion of career opportunities related to sourcing apparel products abroad. Pre: (AHRM 3104 or FMD 3104). (3H,3C)

4964: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4964H: FIELD STUDY
Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4984H: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (PM)

2664: INTRODUCTION TO RESIDENTIAL PROPERTY MANAGEMENT
The history of property management, roles and responsibilities of managers, developing effective marketing and maintenance strategies, fair housing, and landlord-tenant law. (3H,3C)

2674: MULTIFAMILY PROPERTY MANAGEMENT AND OPERATIONS
Multifamily rental real estate including detailed examination of operational and financial aspects of multifamily property management. (3H,3C)

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3634: DEVELOPING AFFORDABLE AND SPECIALIZED HOUSING
Development and operation management of affordable multifamily, military, and student housing, as well as community associations and mixed-use housing developments. Consideration of consumer lifestyles, financial circumstances, and sustainability issues for each housing option. Pre: 2674 or AHRM 2674. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4644: ADVANCED PROPERTY AND ASSET MANAGEMENT
Examination of the competencies necessary to maximize the value of real estate assets through effective operations and financial management practices. Includes detailed examination of income maximization, financial reporting, and ownership objectives of real estate investors. Pre: (2674, 4964) or (AHRM 2674,

AHRM 4964). (3H,3C)

4674: MANAGING AND MARKETING HOUSING FOR LATER LIFE
Managing and marketing housing for later life, including active adult communities and assisted living facilities. Pre: Junior Standing (2H,2C)

4674H: MANAGING AND MARKETING HOUSING FOR LATER LIFE
Managing and marketing housing for later life, including active adult communities and assisted living facilities. Pre: Junior Standing (2H,2C)

4684: MANAGING AND LEASING COMMERCIAL PROPERTIES
Examination of commercial property management considerations associated with office building, medical offices, industrial property, and shopping center space relative to leasing and negotiation, maintenance, marketing practices, and legal and fiduciary responsibilities of the property manager. Pre: Junior Standing (3H,3C)

4694: CONTEMPORARY ISSUES IN PROPERTY MANAGEMENT
Issues affecting property management, including ethics, professional management decisions, legislative issues, and current management practices. The course culminates in the analysis of an apartment community and development of a management plan. Pre: 4964 and senior standing in the Residential Property Management option or 5964 and graduate standing Pre: 4964 or 5964 or 4644 or AHRM 4964 or AHRM 5964 or AHRM 4644. (3H,3C)

4914: RESIDENTIAL PROPERTY MANAGEMENT STUDY TOUR
Study tour that examines trends in the multifamily housing industry focusing on marketing, management, design, and customer service. Variable credit 2 credits maximum. Pass/Fail only. Variable credit course.

4964: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4964H: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4984H: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (RED)

1624: RESIDENTIAL DESIGN PRESENTATION
Principles of visual presentation of residential designs, including floor plans, elevations, and section drawings, perspective and paraline drawings, furniture plans, and schedules. Kitchen and Bath industry graphic standards. Introduction to hand and computer drafting. Design Lab/ Studio. (5L,3C)

2234: HOUSING TEXTILES

Identification of structural elements of housing textiles: natural and manufactured fibers; yarns; woven and other fabrics; finishes; and colorants and their applications. Influence of textile structure on serviceability properties of housing textiles. Exploration of sustainable textiles and related labeling as well as housing textile products and safety and health. Selection of textiles for application such as upholstered furniture, window treatment, and carpeting and rugs. Sophomore standing. (3H,3C)

2604: RESIDENTIAL DESIGN
Analysis of residential spaces to meet the needs of residents. Interrelationship of residential spaces, site, and community, including climate, historic tradition, culture and impact on diversity. House construction systems and finish materials. Current and future trends in design, construction and marketing of housing for diverse households. Impact of codes and regulations on residential design and construction. Professional and labor force issues in the housing industry, interpreting residential floor plans, elevations, detail drawings. (3H,3C)

2614: INTRODUCTION RESIDENTIAL TECHNOLOGIES
Principles underlying the selection, use and care of equipment and lighting in the home and the infrastructure that supports home technologies. (2H,2C)

2634: RESIDENTIAL TECHNOLOGIES LABORATORY
Basic principles of home technologies and their applications in the home. Co: 2614. (2L,1C)

2644: HOUSING AND THE CONSUMER
Overview of housing as it relates to consumer needs, values, lifestyles, norms and constraints. Includes structural and tenure alternatives, financial and legal considerations, house design, neighborhood choices, the home buying process, and future directions in housing. Government aspects focus on the history of federal involvement in housing, major housing programs, role of state and local government, and current housing issues and policies. (3H,3C)

2654: RESIDENTIAL ENVIRONMENTS
Application of elements and principles of design in residential spaces and products from diverse cultural perspectives. Examination of human behavior theories that impact the design of residential environments. Development of residential design solutions and processes using computer aided design software. Design Lab/Studio. Pre: AHRM 1014. (1H,3L,3C)

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3624: HOUSE PLANNING II
Principles of space planning, including activity analysis and user needs, as applied to residential settings. Graphic design solutions for specific areas of the home, including social, private, kitchen, and outdoor areas. Pre: (AHRM 2604 or RED 2604), (AHRM 2634 or RED 2634), (AHRM 2654 or RED 2654). (6L,3C)

3644: AMERICAN HOUSING
Overview of the role of housing in family life and society throughout the history of the United States. Exploration of the impact of technology, resources, and societal values on the design and style of housing and products used in the home. (3H,3C)

3674: ADVANCED RESIDENTIAL TECHNOLOGIES
Residential technologies, such as lighting, communications, and security systems, their impact on home activities, and how they can be successfully integrated into the house structure and design. Pre: AHRM

2614 or RED 2614. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4604: ENVIRONMENTAL AND SUSTAINABILITY ISSUES IN HOUSING
Environmental and sustainability issues in single and multifamily housing in the United States encompassing the building, site, lifestyle, energy and water consumption, waste, air quality and toxic materials; analysis and application of social science theories and equity and identity concerns that provide a foundation for the study of environmentally sustainable housing; current and future alternatives for management of energy and water systems and provision of environmentally sustainable housing. (3H,3C)

4604H: ENVIRONMENTAL AND SUSTAINABILITY ISSUES IN HOUSING
Environmental and sustainability issues in single and multifamily housing in the United States encompassing the building, site, lifestyle, energy and water consumption, waste, air quality and toxic materials; analysis and application of social science theories and equity and identity concerns that provide a foundation for the study of environmentally sustainable housing; current and future alternatives for management of energy and water systems and provision of environmentally sustainable housing. (3H,3C)

4624: ADVANCED KITCHEN AND BATH DESIGN
Planning, design, and evaluation of residential kitchens and bathrooms, in relation to the total house plan. Emphasis on planning principles and technical requirements with attention to functional use of the spaces to meet the needs of people. Pre: (AHRM 3624 or RED 3624), (AHRM 3674 or RED 3674). (6L,3C)

4624H: ADVANCED KITCHEN AND BATH DESIGN
Planning, design, and evaluation of residential kitchens and bathrooms, in relation to the total house plan. Emphasis on planning principles and technical requirements with attention to functional use of the spaces to meet the needs of people. Pre: (AHRM 3624 or RED 3624), (AHRM 3674 or RED 3674). (6L,3C)

4654: ADVANCED TOPICS IN HOUSE PLANNING
Advanced topics in house planning, particularly kitchen and bath design, with emphasis on independent work of portfolio quality. May be repeated for a maximum of 6 credits. Pre: AHRM 4624 or RED 4624. (6L,3C)

4664: UNIVERSAL DESIGN
Application and assessment of the principles and strategies of universal design in residential and commercial environments, accessibility regulations and guidelines, products, and technologies. Demographic changes affecting global society. Disabilities and changes throughout the lifespan that affect people's ability to interact with their environments. Marking strategies to promote universal design communities, products, environments and technologies. Methodologies to evaluate accessibility. (3H,3C)

4664H: UNIVERSAL DESIGN
Evaluation and design of commercial and residential environments with consideration for accessibility, adaptation, safety, and support of the user(s). (2H,2C)

4764: UNIVERSAL DESIGN LAB
Design of residential spaces that meet the needs of a range of users, including older adults and people with disabilities. Principles of universal design are applied to the spatial requirements and product selection for the home. Pre: AHRM 3624 or RED 3624. Co: 4664. (2L,1C)

4924: HOUSING STUDY TOUR
A study tour designed to examine the housing industry and trends in design, technology, products and processes. Junior standing required. May be repeated for a maximum of 6 credits. Pass/Fail only. Variable credit course.

4964: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4964H: FIELD WORK/PRACTICUM

Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4984H: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Agricultural, Leadership, and Community Education

Head: Tracy Rutherford
Professors: L. V. Crowder, E. K. Kaufman, R. D. Rudd, and T. A. Rutherford
Associate Professors: T. G. Archibald, C. R. Friedel, K.L. Niewolny, and D. M. Westfall-Rudd
Assistant Professors: J. H. Culhane, T. A. Drape, R. J. Rateau, H. Scherer, and K. A. Vines
Instructor: A.D. Council and M.M. Seibel
Adjunct Assistant Professor: S.J. Manchester and Y.C. Ndione
Emeritus Faculty: S. R. Burke, W. G. Camp, J. R. Crunkilton, J. H. Hillison, and J. D. Oliver
Undergraduate Program Director: C. R. Friedel (231-8177; cfriedel@vt.edu)

Web: **www.alce.vt.edu**

Overview

The Department of Agricultural, Leadership, and Community Education at Virginia Tech is committed to preparing students for success in professions that apply agricultural content to social settings. We offer a major in Agricultural Sciences and a minor in Leadership and Social Change. Our Agricultural Sciences students will experience an interdisciplinary program of study designed to address the growing needs of today's evolving agricultural and food systems. The Leadership and Social Change minor is available to students of all majors across the university. The minor embraces a commitment to diversity and an agenda for social change that crosses all disciplines of study.

Agricultural Sciences Major (AGSC)

The Bachelor of Science in Agricultural Sciences is intended for individuals who want to collaborate to address the growing needs of today's evolving agricultural and food systems.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

For additional information about the Agricultural Sciences degree, contact the department's undergraduate

director, Curt Friedel at 540-231-8177 or **cfriedel@vt.edu**.

Leadership and Social Change Minor (ILRM)

The Leadership and Social Change minor is available to students of all majors across the university. The minor embraces a commitment to diversity and an agenda for social change that crosses all disciplines of study. Internships in businesses and organizations are encouraged as an extremely valuable way for students to gain work-related leadership skills.

The Leadership and Social Change minor requirements may be found by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

For additional information about the minor, contact 231-1435, or Richard Rateau, rrateau@vt.edu.

Satisfactory Progress

By the end of the academic year in which the student enrolled in the Agricultural Sciences major has attempted 72 hours (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" will consist of:

- GPA of at least 2.0
- at least 24 credits that apply to the Curriculum for Liberal Education, and
- at least 9 semester credits of departmental requirements.

Undergraduate Course Descriptions (ALCE)

1004: STRENGTHS DEVELOPMENT FOR CAREERS IN AGRICULTURAL SCIENCES
Exploration of self-development and career planning related to personal talents and strengths. Special attention will be devoted to pathways for learning within the Agricultural Sciences degree program. This course is intended for students in their first year of enrollment at Virginia Tech. (1H,1C)

2414 (AINS 2414): IDENTITY AND INCLUSION IN AGRICULTURAL AND LIFE SCIENCES
Examines histories of persons representing different social identities, statuses, space, place, and traditions in agricultural and life sciences. Explores how differences influence experiences individuals may have in agricultural and life sciences. Apply ethical reasoning practices to recognize and addresses critical issues surrounding inclusion of diverse populations within agricultural and life sciences education and leadership. Pre: ENGL 1106. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: EDUCATIONAL PROGRAMS IN AGRICULTURAL AND LIFE SCIENCES
Offers a foundation for student engagement and exploration of educational programs within agricultural and life sciences. Formal and non-formal learning contexts in local community programs. Opportunities include fieldwork assignments. (3H,3C)

3014: LEADERSHIP EFFECTIVENESS FOR PROFESSIONALS IN AGRICULTURAL ORGANIZATION
Designed to assist students in developing a knowledge and understanding of leadership theory and basic skills required to perform effectively in leadership positions within agricultural community situations. (3H,3C)

3074: MATERIALS AND PROCEDURES OF AGRICULTURAL CONSTRUCTION
Introduction to materials selection and construction procedures for carpentry, concrete, and masonry construction. Understanding and skills applicable to construction of agricultural buildings. Junior standing or consent of instructor required. (1H,6L,3C)

3084: AGRICULTURAL METAL FABRICATION
Introduction to metal working tools, equipment, and processes. Fundamentals of hot and cold metal working, plumbing, and welding applications, including inert gas welding processes. Junior standing or consent of instructor is required. (1H,6L,3C)

3624: COMMUNICATING AGRICULTURE & LIFE SCIENCES IN WRITING
Development of communication skills necessary to deal with the general public and audiences in the food, agriculture, and natural resources fields. Emphasis on writing and on creation of a portfolio including multiple types of written communication. (3H,3C)

3634: COMMUNICATING AGRICULTURE & LIFE SCIENCES IN SPEAKING
Development of strategies and techniques for effective oral communication in the professions related to food, agriculture, and natural resources. Emphasis on oral, visual, and interpersonal communication, as well as group leadership and meeting management. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4004: TEACHING ADULTS IN AGRICULTURE
Organizing classes, developing programs of instruction and teaching techniques applicable to out-of-school groups in Agriculture. (2H,2C)

4014: INTRO TO COOPERATIVE EXTENSION
An overview of the Cooperative Extension Service as it applies to non-formal education for citizens and communities. Major areas discussed include history, organization, functional areas, responsibilities of local agents, employment in extension, and educational program planning. (3H,3C)

4024: MANAGING AGRICULTURAL SUPERVISED OCCUPATIONAL EXPERIENCE PROJECT
Major emphasis will be given to the agricultural teacher's responsibility for supervision of the Supervised Occupational Experience Program (SOEP). The course will emphasize the ownership project, the cooperative placement project, maintaining record books, and supervising the SOEP. (2H,2C)

4034: METHODS OF PLANNING EDUCATION PROGRAMS FOR AGRICULTURE
Course examines the procedures involved in the development of courses, curriculum, and instructional materials for education programs in agriculture. Variable credit course. Pre: ALCE 3004.

4044: AGRICULTURAL SCIENCES SEMINAR
A senior capstone course addressing issues of importance for majors in Agricultural Sciences. The course will emphasize a synthesis of research results from collected data and information on contemporary problems in agriculture and related fields and a sharing of the results. It will emphasize the development of skills in critical analysis. Senior Standing required. (3H,3C)

4054: INTERNSHIP IN COOP EXTENSION
Off-campus participation experience for those preparing to become extension agents in the Cooperative Extension Service. Variable Credit; 6-16 credits. Variable credit course.

4064: AG MECHANICAL LAB MANAGEMENT
Plan, organize, and manage secondary school mechanics laboratories. Management of the instructional program, facility, equipment, inventory, safety, liability, personnel, material control, and student customer work. (2H,3L,3C)

4234: CURRICULUM FOR CAREER AND OCCUPATIONAL EDUCATION
Provides current and prospective career and occupational education teachers with research bases, resources, and available curricula for teaching content in the respective disciplines. Develops the ability to plan, manage, develop, and evaluate curricula. The prerequisite EDCT 2604 will be waived for Agricultural Education students. Pre: EDCT 2604. (3H,3C)

4244: TEACHING AND TRAINING METHODS IN AGRICULTURAL AND LIFE SCIENCES

Survey of strategies for design, implementation, and evaluation of instruction and training practices in agricultural life sciences. Applications of principles in formal and non-formal educational settings, including schools, extension, and industry. Pre: 4234 or AEE 4234. (3H,3C)

4254: ADULT VOCATIONAL&TECHNICAL ED
Theory, practices, and procedures involved in planning, developing, implementing, managing, and evaluating adult education programs in Vocational and Technical Education. Completion of, or concurrent enrollment in, courses in teaching methods and curriculum required. (3H,3C)

4304: COMMUNITY EDUCATION AND DEVELOPMENT
Comprehensive examination of community education and development. Community/sustainable community development, strategies for mobilizing social change in/with communities. Explore participatory, popular, and community-based education from rural and urban settings. Globalization, sustainability, and social movement discourse with emphasis on agricultural, health, and food system examples. Pre: Junior standing. (3H,3C)

4744: METHODS, MATERIALS AND PRACTICES IN INSTRUCTION
Planning, using, evaluating classroom procedures; selection and organization of subject content and materials in vocational and technical education. Maximum credit: 6 Consent required. Variable credit course. Co: EDCT 4754.

4754: INTERNSHIP IN EDUCATION
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Recommendation of program area and successful completion of Professional Studies required. Variable credit course.

4884: YOUTH PROGRAM MANAGEMENT
Organizational design of educational youth programs such as 4-H and FFA, including administrative planning, human resource development, recruitment, marketing, and budgeting. (3H,3C)

4964: FIELD STUDY/PRACTICUM
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (LDRS)

1015-1016: EXPLORING CITIZEN LEADERSHIP
This two-semester interdisciplinary course offers an introduction to citizen leadership. 1015 explores traditional and contemporary leadership theory and competencies by comparing cultural contexts of leadership. 1016 introduces leadership praxis (action and reflection) as a method of research and service designed to continually refine leadership theory, competencies, and values. (3H,3C)

2014: PRINCIPLES OF PEER LEADERSHIP
Examine theories and basic principles associated with being a positive influence on fellow students and develop leadership skills utilized to motivate peers in teamwork-based scenarios. Concurrent experience required serving as a peer leader. (3H,3C)

2964: FIELD STUDY
May be repeated for a maximum of 6 credits. Variable credit course.

2974: INDEPENDENT STUDY

Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3104: THE DYNAMICS OF LEADERSHIP
This course examines advanced leadership theories and leadership effectiveness in today's organizations. Pre: 1015. (3H,3C)

3304: ELEMENTS OF TEAM LEADERSHIP
The focus of this course is to enable students to develop effectiveness in leading, delegating, and communicating within a team environment. An emphasis will be placed on emotional intelligence in teams, team management, and effective team processes. Pre: 1015. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4044: LEADERSHIP STUDIES CAPSTONE
Culmination of comprehensive knowledge gained about leadership and social change throughout a student's undergraduate career. Involves reflection on collegiate leadership experiences and coursework in the leadership and social change minor. Results in student development of an electronic portfolio (i.e., ePortfolio). Pre: Senior standing. Pre: 1015. (1H,1C)

4754: INTERNSHIP
Variable credit course.

4964: FIELD STUDY
May be repeated for a maximum of 6 credits. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Honors Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors Variable credit course.

Aerospace and Ocean Engineering

Head, Rolls-Royce Commonwealth Professor of Marine Propulsion: E.G. Paterson
Assistant Head for Academic Affairs: R.A. Canfield
Assistant Head for Laboratory Facilities: M.K. Philen
Assistant Head for Graduate Studies: M. Patil
Fred D. Durham Professor: J.A. Schetz
Kevin Crofton Professor: M.L. Psiaki
NAVSEA Chair Professor: A.J. Brown
Norris and Laura Mitchell Professor: R. K. Kapania
Northrop Gruman Sr Faculty Chair Professor: J.T. Black
Professor of Practice: P. Artis
Professors: A.J. Brown, R.A. Canfield, W.J. Devenport, R.K. Kapania, E.G. Paterson, M.L. Psiaki, C.J. Roy, J.A. Schetz, C. Sultan, and C.A. Woolsey
Collegiate Professors: P. Raj and K.A. Shinpaugh
Associate Professors: J.T. Black, S. Brizzolara, O. Coutier-Delgosha, S. England, M. Farhood, K.T. Lowe, M. Patil, M.K. Philen, J.S. Pitt, and G.D. Seidel
Assistant Professors: C.S. Adams, W.N. Alexander, C.M. Ikeda, S. Choi, M. Joerger, L. Massa, B. Srinivasan, K.G. Wang, and H. Xiao
Adjunct Professors: A. Basovich, W. Grossman, L. Ma, and W. Oberkampf
Research Professors: A. Borgoltz and M. Kuester
Professors Emeritus: E.M. Cliff, W.C. Durham, B. Grossman, E.R. Johnson, J.F. Marchman, W.L. Neu, R.L. Simpson, and R. Walters
Faculty Affiliates: S. Bailey, R. Batra, R.A. Burdisso, G. Earle, M. Hajj, K. Kochersberger, R. McGwier, W. Scales, M.K. Spakovsky, D. Stilwell, P. Tarazaga, L. Watson, and M. Weaver

Web: **www.aoe.vt.edu**
E-mail: **aoe-undergrad-advising-g@vt.edu**

Overview

The Kevin T. Crofton Department of Aerospace and Ocean Engineering offers a Bachelor of Science degree in aerospace and ocean engineering. Students may major in either aerospace engineering or ocean engineering. These majors share many course requirements, because the two curricula cover a broad range of common interests and offer a wide range of technical electives. Students may double major—aerospace with ocean engineering or ocean with aerospace engineering. The Department also offers a minor in naval engineering, which is open to non-AOE students.

The undergraduate programs' educational objectives are that graduates will combine their undergraduate education and post-graduation experience to:

- Be successful in entry-level professional positions or in graduate study in aerospace and ocean engineering.
- Apply the theoretical, experimental and computational fundamentals of science and engineering to professional practice, advanced study and continuing professional development.
- Apply their broad understanding of fluid dynamics, vehicle dynamics and control, propulsion and structures to design and synthesis of aerospace or ocean systems in a team environment.
- Communicate their work effectively to both experts in their field and non-technical individuals.

The department's curricula are vehicle oriented, with an emphasis on propulsion, aero/hydrodynamics, stability and control, vehicle performance, vehicle structures, and energy and the environment. A year-long capstone design experience in the senior year uses the group design process to both better simulate the way design is done in the real world and promote the benefits of collaborative learning.

AOE graduates have been highly successful in the aerospace and ocean fields. About 15% of our graduates continue their studies in graduate school, while most of the rest find excellent employment opportunities in the aerospace and related industries and in the shipbuilding, naval engineering, and ship design fields. Some also choose to go into related fields such as automotive engineering, structural engineering, environmental engineering, as well as into professions such as law or medicine.

AOE is home to a number of unique facilities, including Stability, Open-Jet, Boundary-Layer, Low Speed, Transonic, Supersonic, and Hypersonic Wind Tunnels; the Advanced Propulsion and Power Laboratory (APPL), Space@VT building, the Kentland Experimental Aerial Systems Laboratory (KEAS), the Hydro-Elasticity Laboratory, Hydrodynamics Laboratory, Marine Robotics Laboratory, and Newport News Shipbuilding (NNS) / Aerospace and Ocean Engineering (AOE) Teaching and Research Laboratory.

The department encourages students to seek internships and to participate in the Cooperative Education Program, which gives qualified students valuable industrial experience while working toward their engineering degrees. The department's required design courses often include multidisciplinary projects.

The Aerospace Engineering and Ocean Engineering programs are accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**. The department also offers programs of study leading to M. Engr., M.S., and Ph.D. degrees.

AOE students must meet all Pathways requirements and only certain "free" electives and courses designated as "P/F Only" may be taken on a Pass/Fail basis. Lists of approved electives including technical, math, Liberal Education, and other electives are available on the department's web page: **www.aoe.vt.edu/undergrad/undergrad-advising/index-undergrad-advising.html**.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (AOE)

2024: THIN-WALLED STRUCTURES
Basic structural elements of stringer-stiffened thin-walled structures, forces, moments, stresses, and deformation of segmented bars/beams, flexure stress and deflection of beams principal plane, plane of bending and plane of loading for beams with asymmetric cross sections, stresses, and twist due to torsion, shear flow and shear center in open and closed stiffened thin-walled structures, stiffened multicell beams, materials properties and selection. Pre: ESM 2114 or (ESM 2104, ESM 2204), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). Co: MATH 2214. (3H,3C)

2054: ELECTRONICS FOR AEROSPACE AND OCEAN ENGINEERS
Electrical circuits. Discrete passive and active electrical components. Phasors and impedence. AC power analysis. Digital electronics. Electronics for autonomous and piloted aerospace and ocean systems. Electronics for vehicle navigation, guidance, and control. Instrumentation and data acquisition systems. (2H,3L,3C)

2074 (ESM 2074): COMPUTATIONAL METHODS
Solving engineering problems using numerical methods and software, truncation and round-off error, root finding, linear and polynomial regression, interpolation, splines, numerical integration, numerical differentiation, solution of linear simultaneous equations. A grade of C- or better is required in the prerequisite. Pre: ENGE 1114 or ENGE 1216 or ENGE 1434 or ENGE 1414. (2H,1.5L,2C)

2104: INTRODUCTION TO AEROSPACE ENGINEERING AND AIRCRAFT PERFORMANCE
Overview of aerospace engineering from a design perspective; introductory aerodynamics, lift, drag, and the standard atmosphere; aircraft performance, stability, and control; propulsion; structures; rocket and spacecraft trajectories and orbits. Co: ESM 2104 or ESM 2114. Pre: ENGE 1216, PHYS 2305. (3H,3C)

2114: FUNDAMENTALS OF FLIGHT TRAINING AOE
Foundational course to prepare students with knowledge of basic aeronautics to take the Federal Aviation Administration Knowledge Exam, a requirement for the award of a private pilot's license. Explores airplane systems and functions, flight operations, weather, aeronautical navigation, communications, human factors, and federal aviation regulations. (3H,3C)

2204: INTRODUCTION TO OCEAN ENGINEERING
Introduction to the design of ocean vehicles and offshore structures. Buoyancy. Hull geometry, body plan drawing, coefficients of form. Hydrostatic calculations. Intact and damaged stability of ocean vehicles and offshore structures. Large angle stability. Stability criteria for design and related rules and regulations. Marine economics. Pre: ENGE 1216, PHYS 2305. Co: MATH 2204. (3H,3C)

2664 (ECE 2164): EXPLORATION OF THE SPACE ENVIRONMENT
This introductory course covers a broad range of scientific, engineering, and societal aspects associated with the exploration and technological exploitation of space. Topics covered include: science of the space environment, space weather hazards and societal impacts, orbital mechanics and rocket propulsion, spacecraft subsystems, applications of space-based technologies. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Variable credit course.

3014: FLUID DYNAMICS FOR AEROSPACE AND OCEAN ENGINEERS
Fundamentals of fluids: stress, statics, viscosity, laminar and turbulent flow. Conservation of mass and momentum. Vorticity, circulation, and lift. Navier-Stokes equations. Ideal flow in two dimensions, streamlines, stream function, velocity potential, superposition. Thin airfoil theory. Physics of laminar and turbulent boundary layers and of transition. Boundary layer equations and basic tools for boundary layer calculation. Collaborative problem solving. Pre: (2104 or 2204), MATH 2214, ESM 2304. (3H,3C)

3034: SYSTEM DYNAMICS AND CONTROL
Free and forced response of first, second, and higher order linear, time-invariant (LTI) systems in frequency and time domains. Modeling of low-order mechanical systems. Transmission and absorption of vibrations. Transient and steady state performance specifications. Introduction to closed-loop control using proportional-integral-derivative (PID) feedback. Closed-loop stability analysis using root locus method. Pre: ESM 2304, (MATH 2214 or MATH 2214H). (3H,3C)

3044: BOUNDARY LAYER AND HEAT TRANSFER
Concepts of viscous flows and physical properties equations of laminar motion with heat and mass transfer; exact and approximate solutions; finite-difference methods; transition to turbulence; analysis in turbulent flows. Conduction and convective heat transfer. Pre: 3014, (3164 or 3264 or ME 2134 or ME 3134), MATH 4564. (3H,3C)

3054: EXPERIMENTAL METHODS
Fundamental terminology of experimental work and testing in aerospace and ocean engineering. Flow quantities, displacement, and strain measurements of simple structures in both static and dynamic settings. Analog and digital instrumentation. Data acquisition systems and appropriate software. Through teamwork design, prepare, and conduct an experiment, and document its results and findings. Statistical concepts. Pre: 2054, 3014, 3034. (3H,3C)

3094 (MSE 3094): MATERIALS & MANUFACTURING FOR AERO & OCEAN ENGINEERS
This course introduces the student of Aerospace and/or Ocean Engineering to the fundamental properties of materials typically required for structural design. The performance characteristics of metals, ceramics, polymers, and composites are presented and contrasted. Foundation principles underlying materials manufacturing are also presented with the goal of providing an understanding of how processing affects material properties and performance. Must have a C- or better in pre-requisite CHEM 1035. Non-MSE Majors only. Pre: CHEM 1035. Co: ESM 2204, PHYS 2305. (3H,3C)

3114: AERODYNAMICS & COMPRESSIBILITY
Inviscid aerodynamics. Wings and wing theory for low speed flight. How and when compressibility becomes important. Integral form of the conservation equations and thermodynamics. One-dimensional steady compressible flow, nozzle flows. Compressible flow with heat addition. Oblique shock waves and Prandtl-Meyer expansions. Supersonic airfoils. Aerodynamics at subsonic and transonic speeds. Pre: 3014. Co: 3164. (3H,3C)

3124: AEROSPACE STRUCTURES
Inertia loads on aerospace structures, introduction to 3D elasticity including strain-displacement relations, stress-strain relations, stress transformation, and equations of equilibrium, plane stress and plane strain elasticity, stress concentration factors, aerospace materials and failure criteria, margins of safety analysis, plate bending, structural stability. Pre: 2024 or 3024. (3H,3C)

3134: AIR VEHICLE DYNAMICS
Nonlinear kinematic and dynamic equations of aircraft motion; estimation of stability derivatives from aircraft geometry; determination of steady motions; linearization; longitudinal and lateral-directional small perturbation equations; static and dynamic stability of equilibrium flight. Pre: 3034. (3H,3C)

3144: SPACE VEHICLE DYNAMICS
Attitude representations and equations of rotational motion for rigid and multibody spacecraft; attitude determination; linearization and stability analysis of steady motions; effect of the gravity gradient; torque thrusters and momentum exchange devices. Pre: 3034, 3154. (3H,3C)

3154: ASTROMECHANICS
This course teaches the application of Newton's Laws to the dynamics of spaceflight. Topics include the two-body problem equations of motion, Kepler's Laws, classical orbital elements, energy and time-of-flight relations, orbit specification and determination, orbital maneuvering and orbit transfers, patched conic approximations, and relative motion. Pre: ESM 2304. (3H,3C)

3164: AEROTHERMODYNAMICS AND PROPULSION SYSTEMS
The fundamental principles of aerothermodynamics applied to aerospace propulsion system performance analysis and design. Foundations of thermodynamics, heat transfer, compressible fluid mechanics, and combustion. Applications of principles to air-breathing and rocket engines. Pre: 3014. Co: 3114. (3H,3C)

3214: OCEAN WAVE MECHANICS
Introduction to theory of wave in deep and shallow water, including wave generation and propagation. Description of wave statistics and spectral representation for realistic ocean conditions. Introduction to ocean acoustics. Co: 3014, MATH 4564 (3H,3C)

3224: OCEAN STRUCTURES
Overview of surface ship, submarine and offshore structural systems, materials and loadings. Application of beam and plate bending and buckling theories. Frame structural analysis. Fatigue analysis. Pre: 2024. (3H,3C)

3234: OCEAN VEHICLE DYNAMICS
Nonlinear kinematic and dynamic equations of rigid vessel motion in water; hydrostatic and hydrodynamic forces in calm water; motion response to regular and irregular waves; single, multiple and coupled motions degrees of freedom; spectral analysis of response of random seas; statistical analysis of extreme motion response; impact of seakeeping criteria on ocean vehicles design; principles of hydroelasticity; principles of maneuvering of surface and underwater vehicles. Pre: 3014, 3034, 3214. (3H,3C)

3264: THERMODYNAMICS AND MARINE PROPULSION
Fundamental thermodynamics and power cycles; marine propulsion plants and transmission systems; methods of estimating resistance of ocean vehicles; propulsion devices and their efficiencies; introduction to propeller theory; cavitation. Pre: 2204, 3014. (3H,3C)

4004: STATE-SPACE CONTROL
Control design and analysis for linear, state-space system models. Properties of linear, time-invariant control systems: Input/output stability, internal stability, controllability, and observability. Performance and

robustness measures. State feedback control design methods: pole placement, linear-quadratic control. State observers and output feedback control. Applications to control of mechanical systems including ocean, atmospheric, and space vehicles. Pre: 3034. (3H,3C)

4024 (ESM 4734): AN INTRODUCTION TO THE FINITE ELEMENT METHOD
The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied. Pre: (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) or (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

4054 (ESM 4444): STABILITY OF STRUCTURES
Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion. Pre: 3024 or CEE 3404. (3H,3C)

4064: FLUID FLOWS IN NATURE
Course designed to build upon and broaden a basic traditional engineering knowledge of fluid flows into areas concerning a variety of natural occurrences and phenomena that involve fluid motions in important ways. Drag of sessile systems and motile animals, gliding and soaring, flying and swimming, internal flows in organisms, low Reynolds number flows, fluid-fluid interfaces, unsteady flows in nature and wind engineering. Pre: 3014 or CEE 3304 or ESM 3024 or ME 3404. (3H,3C)

4065-4066: AIR VEHICLE DESIGN
Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation. Pre: 2104, 3054, 3114, 3124, 3134, 3164 for 4065; 4065 for 4066. Co: 4105 for 4065; 4106 for 4066. (2H,3L,3C)

4084 (ESM 4084): ENGINEERING DESIGN OPTIMIZATION
Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines. Pre: (MATH 2224 or MATH 2204 or MATH 2204H). (3H,3C)

4105-4106: EXPERIMENTS FOR AEROSPACE DESIGN
Methods for the planning, implementation, assessment and use of experiments in aerospace design problems. 4105: Experiment design, advanced sensor systems, additive manufacturing, uncertainty, data analysis and reporting. 4106: Application of experiments as an integral component of engineering design. Co: 4065 or 4165 for 4105. Co: 4066 or 4166 for 4106. Pre: 3054 for 4105; 4105 for 4106. (3L,1C)

4114: APPLIED COMPUTATIONAL AERODYNAMICS
Development of computational methods for application to wing aerodynamic problems. Incompressible airfoil codes. Panel methods and vortex lattice methods. Finite difference techniques. Transonic and supersonic applications. Pre: 3044, 3114. (3H,3C)

4124: CONFIGURATION AERODYNAMICS
Aerodynamic design of flight vehicles, with emphasis on nonlinear flowfields and configuration concepts. Aerodynamic analysis and design for transonic, supersonic, hypersonic flows, and low speed high alpha flight. Includes case studies of classic configurations and aerodynamic design papers. Pre: 3014, 3114. (3H,3C)

4140: SPACECRAFT DYNAMICS AND CONTROL

Space missions and the way pointing requirements affect attitude control systems. Rotational kinematics and attitude determination algorithms. Modeling and analysis of the attitude dynamics of space vehicles. Rigid body dynamics, effects of energy dissipation. Gravity gradient, spin, and dual spin stabilization. Rotational maneuvers. Environmental torques. Impacts of attitude stabilization techniques on mission performance. Pre: 3034, (4134 or 3154). (3H,3C)

4165-4166: SPACE VEHICLE DESIGN
Fundamental principles of innovative space vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on collaboration, ethics, and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4165: Proven conceptual design process. Parametric analyses. Space vehicle mass estimation. Space vehicle concepts feasibility assessment; 4166: Preliminary design tools and processes. Efficient and light-weight space vehicles. Space vehicle design validation. Pre: 2104, 3054, 3114, 3124, 3144, 3154, 3164 for 4165; 4165 for 4166. Co: 4105 for 4165; 4106 for 4166. (2H,3L,3C)

4174 (ME 4174): SPACECRAFT PROPULSION
Spacecraft propulsion systems and their applications in orbital, interplanetary, and interstellar flight. Rocket propulsion fundamentals; advanced mission analysis; physics and engineering of chemical rockets, electrical thrusters, and propellantless systems (tethers and sails); spacecraft integration issues. Pre: 4234 or ME 4234. (3H,3C)

4205-4206: EXPERIMENTS FOR OCEAN VEHICLE DESIGN
4205: Facilities, instrumentation, and experiments pertinent to ocean engineering in the field of flow measurements and resistance and propulsion tests of surface and underwater vehicles. Analysis and communication of experimental data through technical report writing. 4206: Assessment of ocean system design through experiments, data analysis, and technical report writing. Pre: 3054 for 4205; 4205 for 4206. Co: 4265 for 4205; 4266 for 4206. (3L,1C)

4234 (ME 4234): AEROSPACE PROPULSION SYSTEMS
Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements. Pre: (3114, (3164 or 3264 or ME 3134) or (ME 3404 or ME 3414), ME 2134 or ME 3124). (3H,3C)

4244: NAVAL AND MARINE ENGINEERING SYSTEMS DESIGN
Concepts, theory and methods for the design, integration, and assessment of naval and marine engineering systems considering energy conservation, ship arrangements, system deactivation diagrams, reliability, maintenance, system power, shock and weapons effects, machinery sizing, and system vulnerability. Physics-based mechanical, electrical, thermal, sensor, control, weapon systems, hullform and engine (diesel and gas turbine) models are used to predict total system performance. Linear programming methods and flow-based models are used to optimize systems architecture and size components. Pre: 2054, 2204, 3264, 4264. (3H,3C)

4264: PRINCIPLES OF NAVAL ENGINEERING
This course studies naval engineering systems and systems engineering processes with particular emphasis on: naval missions; combat system performance including radar; underwater acoustics and sonar; ballistics; weapon propulsion and architecture; weapons effects; ship survivability including underwater explosion and shock waves; surface ship and submarine balance and feasibility analysis; and total ship integration. Senior Standing required. Pre: 2204, (MATH 2224 or MATH 2204 or MATH 2204H), PHYS 2306. (3H,3C)

4265-4266: OCEAN VEHICLE DESIGN
Study and application of systems engineering process and ocean engineering principles to the concept exploration, design and development of ocean vehicles including ships, submarines, surface and subsurface autonomous vehicles, boats and yachts. 4265: Emphasis on hullform, power and propulsion, synthesis, balance, metrics and design optimization. 4266: Emphasis on topside/external arrangements, internal arrangements, machinery arrangements, human systems, structural design, and final

assessments of intact and damage stability, weights, space, seakeeping, cost, risk, overall balance and feasibility. Most of the work is done in teams. Pre: 2204, 3214, 3224, 3234, 3264 for 4265; 4265 for 4266. Co: 4205 for 4265; 4206 for 4266. (2H,3L,3C)

4274: INTERMEDIATE SHIP STRUCTURAL ANALYSIS
Analysis of plate bending, buckling, and ultimate strength using computational tools and methods. Calculation of elastic buckling of stiffened panels. Eigenvalue methods for buckling and vibration. Incremental plastic collapse; other progressive collapse. Ultimate strength of large structural modules due to combined loads. Introductory level finite element analysis. Pre: 3224. (3H,3C)

4324: ENERGY METHODS FOR STRUCTURES
Work and energy relationships in structures, flexibility and stiffness influence coefficients, Maxwell and Betti-Rayleigh reciprocal theorems, strain energy and complementary strain energy for thin-walled structures, Castigliano's first and second theorems for trusses and frames, unit action and unit displacement states, direct stiffness method, principles of minimum total potential energy and total complementary energy for bars, beams, and plates, Ritz method, finite element method for bars and beams. Pre: 2024, (3124 or 3224). (3H,3C)

4334: SHIP DYNAMICS
Analysis of motions of rigid body vehicles in water, including influence of added mass and buoyancy. Seakeeping motion responses in waves, wave-induced structural loads, random response analysis via spectral analysis, and extreme response analysis. Introduction to hydroelasticity and maneuvering. Pre: 3014, 3034, (3214 or 4214), MATH 4564. (3H,3C)

4344: DYNAMICS OF HIGH-SPEED MARINE CRAFT
Introduction to the dynamics of high-speed craft, including surface effect ships, hydrofoil vessels, semi-displacement monohulls and catamarans, and planing vessels. Co: 4334 or 3234. Pre: 3264. (3H,3C)

4404 (MATH 4404): APPLIED NUMERICAL METHODS
Interpolation and approximation, numerical integration, solution of equations, matrices and eigenvalues, systems of equations, approximate solution of ordinary and partial differential equations. Applications to physical problems. A student can earn credit for at most one of 3414 and MATH 4404. Pre: MATH 4564, (ESM 2074 or AOE 2074). (3H,3C)

4414: COMPUTER-AIDED SPACE MISSION PLANNING
Design and analysis of space missions. Basic orbital mechanics and access between spacecraft and ground station. Advanced orbit visualization. Prediction of spacecraft position observation under constraints. Communications and link budgets. Terrain modeling and impact on performance. Constellation design and coverage. Orbital perturbations. Dynamics of airplanes and space launch vehicles. Interplanetary mission design. Pre: 2074, (4134 or ECE 2164). (1H,1C)

4434: INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS
Euler and Navier-Stokes equations governing the flow of gases and liquids. Mathematical character of partial differential equations. Discretization approaches with a focus on the finite difference method. Explicit and implicit solution techniques and their numerical stability. Introduction to verification, validation, and uncertainty quantification for computational fluid dynamics predictions. Co: AOE 3044 or ME 3404 or ESM 3016. Pre: MATH 2214. (3H,3C)

4454: SPACECRAFT POSITION/NAVIGATION/TIMING AND ORBIT DETERMINATION
Position/Navigation/Timing (PNT) measurements and optimal batch filter estimation methods for spacecraft with emphasis on orbit determination; GPS position/velocity/time point solutions; linearized state transition matrices; batch least-squares filter Orbit Determination (OD) solutions from a time series of observations; precision and accuracy assessment using covariance and overlap statistics; one-way and two-way radio range and range-rate observations; optical bearings observations; non-Keplerian orbital effects. Pre: 3154. (3H,3C)

4474: PROPELLERS AND TURBINES
Theory, numerical methods, and experimental techniques for analysis and design of propellers and

turbines. Geometry description and creation of computer models. Analysis of inflow from wakes and atmospheric boundary layers. Performance characteristics including open-water and multi-quadrant operation, scale effects, and standard series data. Theoretical analysis and selection of airfoil and hydrofoil sections. Theory and numerical methods for propellers and turbines, including computational fluid dynamics (CFD) simulation. Design of wake-adapted propellers. Design of wind-turbine rotors in steady wind. Structural analysis of propeller and turbine blades. Wind- and water-tunnel testing for thrust and torque. Pre: 3014. (3H,3C)

4624: FOUNDATIONS OF AERO AND HYDROACOUSTICS
Fundamental background to the field of aero/hydroacoustics. Quantifying sound levels, acoustic intensity, the acoustic wave equation, and linear acoustics. Fluid dynamics, turbulence, and thermodynamics in aeroacoustics. Lighthill 's equation, and Curle's equation. Characterization and identification of aeroacoustic sources. Leading and trailing edge noise. Basics of aeroacoustic wind tunnel testing. Pre: 3014, 3054. (3H,3C)

4634: WIND TURBINE TECHNOLOGY AND AERODYNAMICS
Aerodynamics and elastic behavior of a modern wind turbine. Internal and aerodynamic loads of wind turbines. Locating wind turbines with respect to fatigue, annual power and noise productions. Aeroelastic behavior of wind turbine blades. Generators, transformers and power converters used in wind energy. Historical, economic, political, and innovation issues related to wind energy and power grid integration. Pre: 3014, 3124. (3H,3C)

4654 (ECE 4154): SPACE WEATHER: THE SOLAR WIND AND MAGNETOSPHERE
Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earth's magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation. Pre: ECE 3105 or AOE 3014. (3H,3C)

4804: SPECIAL TOPICS IN DYNAMICS, CONTROL, AND ESTIMATION
Advanced undergraduate topics in dynamics, control, and estimation related to a particular class of aerospace and ocean engineering systems. Sample course topics include navigation and guidance, aircraft flight control, and ocean vessel motion control. May be repeated 2 times with different content for a maximum of 9 credits. Pre: 4004. (3H,3C)

4814: SPECIAL TOPICS IN PROPULSION
Advanced undergraduate topics in propulsion for aerospace and ocean vehicles. Covers technical, environmental, and economic challenges and opportunities in contemporary and future propulsion concepts. Comparative analyses of conventional and advanced propulsion systems and propulsion/vehicle integration concepts based upon first principles. Topics include distributed propulsion, green propulsion and propulsion/airframe integration. May be repeated with different content for a maximum of 6 credits. Pre: 3164 or 3264. (3H,3C)

4824: SPECIAL TOPICS IN ENERGY AND THE ENVIRONMENT
Advanced undergraduate topics in energy and the environment related to aerospace and ocean engineering systems. Sample course topics include renewable energy and energy management. Pre: 3014. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Animal and Poultry Sciences

Head: David E. Gerrard
John W. Hancock, Jr. Professor: E. A. Wong
Paul Mellon Distinguished Associate Professor of Agriculture: S. E. Johnson
Professors: R. A. Dalloul, A. D. Ealy, M. J. Estienne, D. E. Gerrard, S. P. Greiner, H. Jiang, S. E. Johnson, J. W. Knight, E. J. Smith, and E. A. Wong
Associate Professors: M. A. Cline, D. E. Eversole, E. R. Gilbert, M. E. Persia, M. A. Rhoads, R. R. Rhoads Jr., and C. M. Wood
Assistant Professors: S. Campbell, S. W. El-Kadi, E. Feuerbacher, L. Jacobs, T. Jarome, K. Lee, C. M. Leeth, V. Mercadante, G. Morota, R. White, and T. B. Wilson
Instructors: L. Bergamasco, B. Sheely, and N. Tamim
Research Assistant Professor: H. Shi
Career Advisors: J. S. Bradley, D. E. Eversole, P. M. Mercadante, and N. Tamim

Web: **www.apsc.vt.edu**
E-mail: **apsc@vt.edu**

Overview

The Department of Animal and Poultry Sciences provides students with a broad science-based education tailored to meet their needs and career goals. The program prepares students for careers in livestock, poultry, equine, companion animals, laboratory animals, agribusiness, research, and teaching. The curriculum also provides preparation for professional schools including veterinary medicine, medical school and other health professions, graduate school, etc. This major combines education in the basic sciences of animal and poultry nutrition, genetics, and physiology with management principles as applied to the raising and merchandising of beef cattle, horses, poultry, sheep, swine, and their products. Undergraduate students are encouraged to participate in independent studies, undergraduate research, and internship programs. Study abroad opportunities are also available.

Students choose among three options: production/business, science, or pre-vet. Within each option, emphases are offered in the areas of equine, livestock, poultry, and companion/laboratory animals. Specific requirements may be obtained from the departmental advising office (540) 231-7651, by e-mail (**apsc@vt.edu**), or on the web at **www.apsc.vt.edu**.

The department also offers opportunities for graduate specialization in the following fields: nutritional physiology, genetics and genomics, immunology and health, growth and development, animal management and environmental interactions. M.S. and Ph.D. programs are offered (see **Graduate Catalog**).

Course Requirements for Majors

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Note: Advisors work with students to individualize the course of study.

* Electives must include Area 2, Area 6 and Area 7 selections; 38 emphasis requirements & restricted electives approved by student advisor; and a maximum of 12 credits of free electives.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Animal and Poultry Sciences.

Satisfactory progress requirements toward the B.S. in Animal and Poultry Sciences can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (APSC)

1454: INTRODUCTION TO ANIMAL & POULTRY SCIENCE

Survey of systems of livestock and poultry production including: concepts and terminology pertaining to management and marketing; types and breeds of livestock and poultry; and an introduction to nutrition, genetics, physiology, and management of beef cattle, horses, sheep, swine and poultry. Co: 1464. (3H,3C)

1464: ANIMAL AND POULTRY SCIENCE LABORATORY
Management practices and concepts related to efficient livestock and poultry production and marketing are taught through demonstrations and hands-on experience. Co: 1454. (3L,1C)

1504: ANIMAL AND POULTRY SCIENCES FIRST YEAR EXPERIENCE
Orientation course for freshman and transfer APSC students providing skills, resources and fundamental knowledge to enhance learning experiences and support success. Skills, resources, opportunities, curriculum, and career planning. Emphasis on inquiry, problem-solving skills, critical thinking and integration of ideas and experiences to encourage life-long learning. (1H,1C)

1524: BEGINNING EQUITATION
Introduction to modern forward seat equitation. No previous experience necessary. Familiarization with parts of the horse, tack, gaits. Control at walk, trot, canter, including trot work over rolling terrain. Pass/Fail only. (4L,1C)

1624: LOW INTERMEDIATE EQUITATION
Increased riding at canter and sitting trot. Control of horse over moderately difficult terrain including galloping. Beginning cavelletti work. Pass/Fail only. Pre: 1524. (4L,1C)

2004: ANIMAL AND POULTRY SCIENCES SEMINAR
Identification of primary and secondary career objectives for Animal and Poultry Science majors; planning for completion of a capstone learning experience in the major. Identification of curricular and extracurricular activities to increase career opportunities. Improvement of professional and technical writing skills applicable to the animal sciences field. Pre: 1504. (1H,1C)

2025-2026 (NEUR 2025-2026): INTRODUCTION TO NEUROSCIENCE
Introduction to the fundamental principles of neuroscience. 2025: Structure and function of central nervous system in humans and other animals, signal processing and transmission, development of neural and brain circuits, encoding and transmission of sensory and perceptual information, motor control/movement. 2026: Complex brain processes including learning, memory, emotion, decision making, social behavior, and mental and functioning. Pre: BIOL 1105 or BIOL 1005 for 2025; 2025 for 2026. (3H,3C)

2104: POULTRY LABORATORY
Anatomy and physiology of birds including species-specific specializations in anatomical structure and body composition, musculoskeletal, respiratory, reproductive, endocrine, digestive and urinary systems. Relationship of these concepts to growth and egg production. Includes handling live birds. Pre: 1454, 1464. Co: ALS 2304. (3L,1C)

2114: LIVESTOCK MANAGEMENT AND HANDLING
Safety in livestock handling; animal behavior; care, housing, and managerial practices related to beef cattle, sheep, and swine taught through experiential activities. Pre: 1454, 1464. (3L,1C)

2124: HORSE MANAGEMENT LABORATORY
Principles of safe horse handling practices and applied horse management skills, taught through experiential activities. Pre: 1454, 1464. (2L,1C)

2164: COMPANION AND LABORATORY ANIMAL CARE AND HANDLING
Brief history of companion and laboratory animals. Outline of the major anatomical and physiological characteristics, first aid and basic care. Principles of husbandry and handling techniques. Institutional Animal Care and Use Committee training. Pre: 1454, 1464. (2L,1C)

2424: INTRODUCTION TO THE EQUINE INDUSTRY
Introduction to the horse and equine industry. Survey of breeds and conformation; breeding, management, equipment, facilities, and marketing of the successful horse operation. (3H,3C)

2464: INTRODUCTION TO COMPANION ANIMALS
Appropriate care and resulting well-being of dogs, cats, and other animals that are used primarily for companionship and recreation require knowledge of their evolution, natural habitats, species and breed characteristics, behavior, breeding, feeding, housing and training. This course integrates these topics to promote a symbiotic human-animal relationship. Information regarding the scope and impact of the companion animal industry will be discussed along with a survey of associated careers. Pre: BIOL 1106. (2H,2C)

2524: INTERMEDIATE EQUITATION
Intermediate work in horseback riding with special emphasis on development of the forward seat and skills required for jumping. Elementary dressage movements. Pass/Fail only. Pre: 1624. (4L,1C)

2624: BEGINNING EQUITATION OVER FENCES
Introduction of jumping skills for the unskilled as well as review of jumping skills for experienced riders. Rider should have skills at trot and canter. Pass/Fail only. Pre: 2524. (4L,1C)

2824: EQUINE CONFORMATION AND BIOMECHANICS
Evaluation of equine conformation as related to locomotion, athletic performance and soundness. Basic understanding of breed standards, gaits, and rules and regulations pertaining to various equine sports disciplines, from both domestic and global perspectives. Investigation of current scientific literature regarding equine conformation and biomechanics. (1H,2L,2C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Pass/Fail only. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Pass/Fail only. Variable credit course.

3064: COMPANION AND LABORATORY ANIMAL SCIENCE
Comparative aspects of companion and laboratory animals including physiology, anatomy, nutrition, genetics and reproduction. Normal behaviors along with techniques of behavior modifications. Pre: ALS 2304. (3H,3C)

3134 (DASC 3134): ANIMAL AGRICULTURE AND THE ENVIRONMENT
Environmental issues associated with animal agriculture. Nutrient contamination of water resources, odor emission from livestock farms, environmental regulations affecting animal agriculture, and management practices to reduce the impacts of livestock farms on air and water quality. (3H,3C)

3214 (FST 3214): PRINCIPLES OF MEAT SCIENCE
Muscle biology and biochemistry, fresh meat processing, meat merchandising, processed meats, food safety, meat cookery, and regulations. Pre: ALS 2304, CHEM 1036. (3H,3C)

3224: MEAT SCIENCE LABORATORY
Harvesting of livestock, carcass fabrication into wholesale and retail cuts, fresh meat processing and cookery. Handling, processing and displaying fresh and processed beef, pork, and lamb. Applications of Hazard Analysis Critical Control Point (HACCP) and food safety concepts to meat processing environments. Co: 3214. (3L,1C)

3254: ANIMAL PRODUCTS
Products obtained from animals (meat, eggs, dairy, by-products). Effect of production and processing of food animals upon product safety and quality. Pre: ALS 2304. (2H,2L,3C)

3304: EMBRYOLOGY
Normal and teratological embryology are intensively examined from ovulation through hatching or birth. Environmental, nutritional and genetic factors affecting embryogenesis. Even years. Pre: ALS 2304 or BIOL

3404. (2H,3L,3C)

3334: ANIMAL WELFARE AND BIOETHICS
Historical overview of animal welfare and bioethics. Animal welfare issues in farm and companion animals with respect to their use and treatment in the United States and in the global community. The influences of animal protection organizations, consumer groups, politicians, the scientific community, and other stakeholders on the development and enforcement of policies. Pre: Junior Standing. Pre: 1454, ALS 2304. (3H,3C)

3524: INTERMEDIATE EQUITATION OVER FENCES
Establishment of sound jumping skills. Continuation of more advanced flat work. Study of hunter courses and cross country jumping. Pass/Fail only. Pre: 2624. (4L,1C)

3624: ADVANCED EQUITATION OVER FENCES
Advanced methods and techniques for jumping and precision riding. Pass/Fail only. Pre: 3524. (4L,1C)

3684: SPECIAL TOPICS IN ANIMAL AND POULTRY SCIENCES
An advanced, variable-content course which explores a topic in the animal sciences such as a significant contemporary issue; an emerging research area of interest to undergraduates; or a semester-long project involving a small group of students. May be repeated for up to three credits, no more than two credits per term. Pass/Fail only. Pre: ALS 2304. (1H,2H,2C)

3724: APPLIED EQUINE EVALUATION
In-depth analysis of equine conformation and performance. Emphasis on knowledge of breed standards, critical thinking skills, and oral justification of decisions. Equivalent experience may be substituted for the pre-requisite APSC 2824 with instructor approval. Pre: 2824. (1H,3L,2C)

3754: PRINCIPLES OF LIVESTOCK EVALUATION
Selection of market and breeding animals based on subjective and objective methods of evaluation. Basic understanding of evaluation principles, form-to-function, expected progeny differences, and performance records of beef cattle, swine, and sheep. Involves accurate decision making and oral reason presentations. Pre: 1454. (6L,2C)

3764: LIVESTOCK MERCHANDISING
A comprehensive study of the principles and activities involved in successfully promoting and merchandising livestock. A livestock auction (Hokie Harvest Sale) is held at the conclusion of the course to provide experiences in advertising, salesmanship, livestock photography, facility development, sale management, and budgeting. Pre: Junior standing or consent. (2H,2C)

3824: EQUINE BEHAVIOR AND TRAINING
Psychology and ethology of equine behavior. Application of fundamental behavioral concepts to the training of horses and modification of undesirable behavior patterns. Preparation and presentation of young horses for show and sale. Pre: 2124. (1H,3L,2C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4004: CONTEMPORARY ISSUES IN THE ANIMAL SCIENCES
Applying critical thinking, ethical reasoning and problem solving in order to make ethical decisions in regard to important contemporary issues in animal agriculture and other areas of the animal sciences; discourse through oral and written communication. Pre: 2004. (3H,3C)

4054 (BCHM 4054): GENOMICS
A contemporary analysis of the development, utility and application of high-resolution methods for the study and manipulation of the complete genomes of organisms. The use of new techniques for genomic, metabolic and protein engineering (functional genomics), including high-throughput methods and nanotechnology, will be emphasized. Pre: BCHM 3114 or BCHM 4116 or BIOL 3774. (3H,3C)

4064: ISSUES IN COMPANION ANIMAL MANAGEMENT
Comparative aspects of companion animals including physiology, anatomy, nutrition, genetics, reproduction and well-being. Normal and aberrant behaviors along with techniques of behavior modification and pharmacological intervention. Critical evaluation of current legal and ethical issues in the companion animal industry. Limited to dogs, cats and caged birds. Pre-requisite: Junior Standing required Pre-requisites may be waived with permission of instructor. Pre: 2464, ALS 3104, ALS 2304. (3H,3C)

4124: EQUINE HEALTH AND DISEASE
Application of principles needed to effectively monitor and manage equine herd health. Focus on information synthesis, situation assessment and decision-making skills to develop preventative care protocols and treat illness. Practical application of horse health care techniques for routine and minor emergency situations. Pre: ALS 2304. (2H,4L,4C)

4224: EQUINE EXERCISE PHYSIOLOGY
Comprehensive study of conditioning the equine athlete using the principles of exercise physiology, energetics, kinetics, and sports medicine. Anatomy and physiology as it relates to exercise, conditioning and fitness assessment; exercise intolerance; performance nutrition; and medical practices used to support equine athletics. Pre: ALS 2304. (3H,3C)

4304 (DASC 4304): PRINCIPLES & PRACTICES OF BOVINE REPRODUCTION
Principles and techniques in reproductive physiology and herd management related to health, record keeping, estrus detection and synchronization, uterus and ovary condition. Ovarian function and superovulation, semen handling, artificial insemination and pregnancy detection are also considered. Pre: ALS 2304. (1H,3L,2C)

4324: EQUINE REPRODUCTION AND NEONATAL CARE
Principles and techniques in equine reproductive physiology and endocrinology. In-depth examination of equine reproduction strategies combined with practical techniques leading to synthesis and evaluation of breeding decisions. Anatomy and physiology of the mare and stallion, estrus detection and manipulation, artificial insemination, semen handling and processing, parturition and early care of neonates will be covered. Other topics will include selection of breeding stock and mating decisions. Pre: ALS 2304. (2H,4L,4C)

4404: COMMERCIAL POULTRY ENTERPRISE MANAGEMENT
Production, management, and reproduction of meat- and egg-type chickens and turkeys. Emphasis is on the application of basic poultry science principles as they relate to commercial poultry enterprises. Advanced topics of economic analysis, program management, and problem solving used in decision making processes in integrated poultry operations. Pre: 2104, ALS 3104, ALS 3204, ALS 3304. (3H,3L,4C)

4414: BEEF AND SHEEP PRODUCTION AND INDUSTRY
Study of the commercial and purebred beef cattle and sheep industries. Principles and applications for successful and profitable beef and sheep production. Pre: 2114, ALS 3104, ALS 3204, ALS 3304. (3H,3L,4C)

4424: HORSE PRODUCTION AND MANAGEMENT
Reproduction, genetics, nutrition, herd health, planning and economics of private and commercial horse farms, and current issues in the horse industry. Pre: 2124, 2424, ALS 3104, ALS 3204, ALS 3304. (3H,3L,4C)

4444: SWINE PRODUCTION
Principles for commercial and seedstock swine production; current management practices, housing and marketing; issues and challenges in the swine industry. Experience in husbandry, research, and other management techniques obtained during laboratory. Pre: 2114, ALS 3104, ALS 3204, ALS 3304. (2H,3L,3C)

4464: COMPANION AND LABORATORY ANIMAL HEALTH AND MANAGEMENT
Animal health, management, well-being, and government regulation in the maintenance, use and enjoyment of companion and laboratory animals. Pre: 2164, 3064, ALS 3104, ALS 3204, ALS 3304. (3H,2L,4C)

4514: ANIMAL GROWTH AND DEVELOPMENT
Meat animal growth and development processes, micro and gross anatomy, stem cell biology and growth, body and carcass composition with application to animal and carcass evaluation. Pre: ALS 2304, ALS 3204. (3H,3C)

4554: ADVANCED LIVESTOCK ENTERPRISE MANAGEMENT
Application of principles needed to manage profitable and sustainable beef cattle, sheep, and swine enterprises. Use of techniques to develop and evaluate strategies resulting in sound livestock enterprise management decisions. Focus on advanced animal management protocols, enterprise analysis, resource allocation, marketing options and risk management. Pre: (AAEC 3404 or AAEC 3454), (APSC 4414 or APSC 4444). (2H,2L,3C)

4624: TOPICS IN EQUINE SCIENCE
Review and critique of scientific literature related to equine science. Focus on creative and critical thinking. Principles and practice of information analysis, synthesis and evaluation through discourse and technical writing. Practical application of research and communication skills. Pre: ALS 2304. (2H,2C)

4954: CAPSTONE EXPERIENCE IN ANIMAL AND POULTRY SCIENCES
Student-defined learning experience that utilizes knowledge and skills already learned to acquire new skills, synthesize information and solve problems in the animal sciences. Requires approval from the department before commencement of the experience, and a final report at its conclusion. Open to APSC majors only. Completion of 75 credits towards the APSC degree required. Pass/Fail only. Variable credit course. Pre: 2004.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Pass/Fail only. Variable credit course.

4974H: INDEPENDENT STUDY
Pass/Fail only. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Pass/Fail only. Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Pass/Fail only. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Architecture

Director - School of Architecture & Design: H. Pittman
Chair - Foundation Program J. Bassett
Chair - Core Professional Program: M. Cortes
Chair - Advanced Professional Program: H. Schnoedt
Chair - Graduate Program:D. Dugas
Professors: K. Albright, M. Breitschmid, H. de Hahn, D. Dunay, R. Dunay, P. Emmons, M. Ermann, J. Jones, S. Piedmont-Palladino, M. Setareh, F. Weiner, and J. Wheeler
Professor of Practice: E. Ruiz-Geli
Associate Professors: J. Bassett, H. Bryon, M. Cortes, D. Dugas, K. Edge, M. Feuerstein, W. Galloway, S. Gartner, E. Grant, S. Martin, M. McGrath, H. Pittman, H. Schnoedt, and S. Thompson
Assistant Professors: J. Bedford, E. Becker, P. Doan, A. Ishida, N. King, S. Tomer, and P. Zellner-Bassett
Assistant Collegiate Professor: K. MacDonald
Visiting Instructors: C. Pritchett and C. Vorster
Adjunct Instructors: S. Bitar, D. Lever, R. Mars, M. Paget, D. Regan, J. Schippers, and D. Snook
Professor Emeritus: W. Brown, R. Chiang, D. Egger, J. Holt, W. Kark, D. Kilper, F. Ruiz, D. Sunshine, J. Wang, S. Poole, and R. Daniel
Associate Professor Emeritus: D. Jones
Assistant Professor Emerita: E. Braaten

Web: **www.archdesign.vt.edu**

Overview

Architecture enriches our lives by offering us environments that are sensibly compelling, thought provoking, and capable of lifting our spirits. In addition to being beautiful, architecture is, by ancient definition, functional and durable. Like art, architecture is permeated by dualities. It is stable and transitory, measurable and immeasurable, and capable of both being touched and touching us. Like science, architecture involves systematic study. Its methods are iterative, experimental, and rely on intense observation. By intertwining the poetic and practical, architecture is uniquely poised to address the challenges of contemporary life and build the culture of the 21st century.

The professional curriculum in architecture requires five years of study for the first professional degree, the Bachelor of Architecture (B. Arch.).

The first professional degree programs at Virginia Tech, the five-year Bachelor of Architecture degree (B. Arch.), the Master of Architecture II (M.Arch.2), and the Master of Architecture III (M.Arch.3) degrees, are fully accredited for the current maximum six-year term of accreditation by the National Architectural Accrediting Board.

All students in the School of Architecture + Design - Architecture, Industrial Design, Interior Design and Landscape Architecture - begin their studies in a common first year foundation program. Following the foundation program, students pursue professional studies in the 2-3 and 4-5 programs.

Foundation Design Program - First Year

Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture, landscape architecture, interior design, and industrial design. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgment and critical understanding. Studies are undertaken in two and three dimensions across multiple scales.

Professional Program - Second, Third, Fourth, and Fifth Years

The Professional Program employs design theory and processes to study the design of buildings. Students conduct an interactive investigation of architectural space, environmental forces, and building technology. Foundations of discipline-specific knowledge are progressively introduced, discussed, and examined as they contribute to the complex totality of a work of architecture. Students explore natural and cultural forces as they relate to architecture through means of representation specific to the discipline. With architecture at the core, the program examines interdisciplinary sources such as art, science, and philosophy for the purpose of establishing the content the discipline shares with other forms of knowledge.

Concepts in the Professional Program are communicated through both traditional drawings and models, as well as through modern virtual tools and digital production. All coursework seeks to develop the ability to conduct a professional written and verbal discourse. Further emphasis is placed on intellectual discipline, constructive dialogue, assertion of interest, and a self-motivated search for critical issues.

The **second year** is characterized by an increase in the complexity of design exercises to foster a better understanding of the interplay between situation, time and desired spatial definition. Architectural constructs of smaller scales build on knowledge of basic design principles studied in the first year. The laboratory discourse focuses on principal elements of architecture and their compositional and material role in space. Architecture as the art of building is conveyed through the detailed study of exemplary built works.

The **third year** provides for study of fundamental design principles, technical concepts and their applications, including measures of quality in architecture. The instructional content of this year articulates and communicates to students the unique nature of architecture through the study of interrelationships of material, construction systems, site, and building programs. The Architecture III design laboratory guides the student's growing experience with practical design problems and provides order to the gradual exploration and learning of the nature and means of achieving architecture. Associated with Architecture Ill are lectures, presentations, and workshops intended to challenge students toward sensible integration of necessary systems and legal responsibilities in the design and construction of buildings.

The **fourth year** builds on the increased comprehension of building systems acquired during the third year. On-campus or off-campus, the aim of the various program options is to promote an in-depth understanding of the relationship between architectural idea and physical building form. On-campus students are offered studio courses with various focus topics. Off-campus options include several VT and non-VT Study Abroad Programs, the Extern Program, the Washington-Alexandria Center, or the Chicago Studio.

Off-campus programs directed by the Virginia Tech School of Architecture + Design include:

- *The Europe Study Abroad Fall Travel Program studies* seminal European historic and contemporary architectural works and urban spaces, which are visited and documented with analytical drawings, sketches, and photographs, supplemented by on-site lectures by architects and professionals. Documented research before and after the program leads students to greater depth of understanding of the issues surrounding the architecture.
- *The Steger Center Residency Program:* Each semester, 16 architecture students take part in this program at Virginia Tech's European Steger Center for International Scholarship in Riva San Vitale, Switzerland. An 18th century villa and its gardens on the southern tip of Lake Lugano provide residence and dining facilities for Architecture + Design students, as well as 30 Virginia Tech students from other academic disciplines. Studio work, courses, research, and travel are directed to advance first-hand knowledge of the architecture, geography, and culture of Europe.
- *The Chicago Studio:* Hosted by significant architecture firms in downtown Chicago, this 4th-year off-campus semester seeks to integrate education and practice in a direct way. Its distinctive structure and curriculum is centered around urban focused studio and course work, with direct input from the profession. Site visits in the Chicago metropolitan area and the lectures and events of the active architecture culture of Chicago contribute significantly to this program.
- *Professional Extern Program* allows students to spend one semester in an approved professional setting and receive up to 12 hours of academic credit. This program provides a valuable link between the academic environment and architectural practices, discipline-related government agencies, and other design offices throughout the world.
- *The Washington-Alexandria Architecture Center* affords students from the School of Architecture + Design and from related College disciplines the opportunity to study with students and faculty from a national and international consortium of schools in the historic urban context of Old Town Alexandria. The Center complex offers studio space, classrooms, exhibition and review spaces, shops, and computer labs for the students and faculty of the consortium. The University also offers a limited number of apartments for students studying at the Center.

In the **fifth year**, students conduct a yearlong advanced study with individual faculty advisors. The in-depth engagement with research, theory, and design is intended to broaden a student's expertise in a particular area within the field of architecture. Fifth-year students are expected to formulate and accomplish advanced high-level work in the form of a terminal project. Working with their advisors, students develop and discuss their research and design progress, and have periodic formal peer reviews throughout the year. Students are required to leave the project documentation of their 5th-year work with the school upon graduation.

The first professional degree programs (B.Arch., M.Arch.2 & M.Arch.3) in architecture are accredited by the National Architectural Accrediting Board (NAAB).

- In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on the extent of its conformance with established educational standards.
- Doctor of Architecture and Master of Architecture degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.
- Next accreditation visit for all programs: 2018

The four-year, pre-professional degree is not offered at Virginia Tech.

Program Requirements

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Graduation Requirements

Upon successful completion of program requirements of the foundation level of study and the professional levels of study in architecture and with completion of 160 credit hours of study, a first professional degree of Bachelor of Architecture is awarded.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Urban Affairs and Planning.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (ARCH)

1014: INTRODUCTION TO ARCHITECTURE: LESSONS IN FORM & CULTURE
Introduction to the discipline of architecture for non-architecture majors. Emphasis on the basic elements of design and the relationships of a culture to the forms, shapes, and structures it expresses in architectural production. (3H,3C)

1015-1016: FOUNDATION DESIGN LABORATORY

Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture, landscape architecture, interior design, and industrial design. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgement and critical understanding. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). (1H,11L,6C)

1024: INNOVATIVE DESIGN THINKING
Engages students in learning environment of the design laboratory, which is interactive inquiry, experimentation, discovery, and synthesis. Develops thinking and making skills in 2D and 3D across multiple scales. Advances abilities to solve problems through exploring strategies with viable consequences. Engages students in a series of iterative drawing, and modeling exercises relevant to architecture and design education. ARCH 1024 is restricted to incoming freshmen. (3H,3C)

1034: SEEING DESIGN: TRANSFORMING OBSERVATIONS
Introduces students to ways of perceiving, and recording the built and natural environment in Southwest Virginia. Introduces students to travel studies as an essential part of their architecture and design education. Transforms students' observational skills. Employs photography and sketching as means of documenting findings. Employs screenprinting and digital technologies as a way to transform documentation. Prepares students for an exhibition of their work, including oral presentations. ARCH 1034 is restricted to incoming freshmen. (3H,3C)

1115-1116: QUALIFYING DESIGN LABORATORY
1115: An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at a beginner's level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgment and critical understanding. Develops fundamental thinking and making skills that advance their abilities to solve problems by exploring strategies toward viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design. 1116: An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at an intermediate level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgement and critical understanding. Advances foundational thinking and making skills that develop their abilities to solve problems by exploring strategies toward viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design. (1H,6L,3C)

2015-2016: ARCHITECTURE II
Introduction to the discipline of architecture, isolating and intertwining fundamentals that contribute to the complex totality that constitute a work of architecture. Explores how architecture concentrates and conveys natural and cultural forces through means specific to the discipline. Focus on fundamentals realized artistically and practically in works by selected architects. Articulates the unique reality of architecture through the study of basic interrelationships of material, construction, site, and program. Introduces the complex interplay of situation, space and time in the making of places. Examines interdisciplinary sources such as art, science, and philosophy for the purpose of establishing the content architecture shares with other forms of knowledge and how that content, expressed through architecture, contributes to human well-being. Concepts communicated through drawings and models. Emphasis on intellectual discipline, dialogue, assertion of interest, and a self-motivated search for critical issues. Pre: 1016. (2H,12L,6C)

2034: ART OF BUILDING
Introduction to contemporary building construction practices and conventions, addressing and examining the physical making of buildings. Constructive conditions will be presented and analyzed based on the materials, assembles, details, performance, and programmatic requirements that inform and comprise a building's physical reality. Pre: 2044. (2H,2C)

2044: BUILDING MATERIALS
Introduction to the attributes of materials with which buildings are built such as masonry, reinforced concrete, steel, stone, timber, glass and insulation; introduction of the impact of soil, vegetation, watersheds and other natural conditions on buildings and their material fabrication. Pre: 1015. (2H,2C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3015-3016: ARCHITECTURE III
First design laboratory for the Professional Program in Architecture. Provides for exploratory investigation and analysis of the fundamental design principles, technical concepts and applications, and the measures of quality in architecture. Co: 3045 for 3015; 3054, 3046 for 3016. (1H,12L,6C)

3045-3046: BUILDING ASSEMBLIES
The designs of building assemblies, elements, systems and sub-assemblies are studied. Building assemblies as controlled by formal idea, geometry, construction, materials, details, structure, function, enclosure, and finish work are considered. Pre: 2016. Co: 3015 for 3045; 3054, 3016 for 3046. (2H,2C)

3054: BUILDING ANALYSIS
Study of exemplary built works of architecture through analysis of design documents, interviews, and inspection of actual construction. Course is completed as a group project resulting in both an oral presentation and a written document. Pre: 3015. Co: 3046, 3016. (2H,2C)

3115-3116: HISTORIES OF ARCHITECTURE
Disciplinary study of architecture across time (pre-history to present) and across continents (Eastern, Western, Northern, and Southern hemispheres). Histories, principles, and factors grounding architecture\031s expression, form, and methods. Architecture as a cultural production reflective of its social, political, artistic, intellectual, technological, and environmental context. Exploration through artifacts, texts, drawings. ARCH 3115: emphasis on artifacts and architecture between 25000 BCE and 1600 CE; ARCH 3116: includes architectural productions from 1600 CE to present. Pre: 1015 for 3115; 3115 for 3116. (3H,3C)

3514: DESIGN-RELATED MEDIA
Properties and uses of various media, materials and processes as tools for analysis, documentation and presentation of the designed environment. Basic skills and techniques relating to photography, printmaking, and pottery will be explored. Repeatable with a maximum of 6 credits. (3H,3C)

3954: STUDIO-STUDY ABROAD
The Europe Studio offers students the opportunity to make comparative studies of European cultures, as well as to study the relationship of culture to the physical environment, the organization of cities, and the history and behavior of their inhabitants. Exercises include analysis and documentation of elements of the physical environment, exploration of the interface between buildings and the fabric of the existing city, and examination of the professional community's reactions to urban design solutions. X-grade allowed. (*H,6C)

3974: INDEPENDENT STUDY
Variable credit course.

3984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4015-4016: ARCHITECTURE IV
Design laboratory in conjunction with alternative studies in one of the College's off-campus centers. Focus on the evaluation of skills developed in the third year professional studies and emphasis toward individualized topical areas of study leading to the development of a thesis project. X-grade allowed. Pre: 3016 for 4015; 4015 for 4016. (2H,12L,7C)

4034: BUILDING CITIES
Analytical studies in the historical evolution of cities, towns and villages. Comparative studies of urban form in relation to their constructive and imaginative means with an emphasis on modern construction processes. Specific case studies in designing and building cities. Co: 4016. (3H,3C)

4044 (LAR 4124): PROFESSIONAL PRACTICE
Introduction to scope and diversity of the building enterprise, addressing private and public macroeconomic, industrial, technical, professional, and regulatory institutions. Analysis of historic evaluation of professional roles and practices; emergence of new modes of practice, including innovative facilities procurement methods. (3H,3C)

4055,4056: ENVIRONMENT AND BUILDING SYSTEMS
A design oriented study of environmental forces, environmental impacts of the built environment, and related building environmental control, life safety and service systems, with concern for the human psycho-physical impacts of building form and systems performance. (3H,3C)

4075-4076: BUILDING STRUCTURES
Building structures in steel, timber, and reinforced concrete; design of typical components: beams, slabs, columns, beam-columns, connections, and foundations; design of retaining walls; the resistance of buildings to gravity and lateral force action; building stability; floor/roof framing systems; design of simple buildings. Pre: ESM 3704. (3H,3C)

4114: IDEAS, CONCEPTS, AND REPRESENTATIONS OF ARCHITECTURE
Survey of ideas, concepts, and representations that have shaped architecture. Particular emphasis is given to ideational constructs and how they have been adapted in the projecting of buildings. Pre: 3016. (2H,2C)

4144: ADVANCED BUILDING STRUCTURES I
Study of long-span building structures. Introduction to geometry, form, and structure of folded and bent surfaces. Study of space grid geometry, close-packing systems, and cellular tensegrity. Approximate design of folded plate structures, single and double curvature shells, single and double layer space frames, suspension roofs, tents, and pneumatic structures. Pre: 4075, 4076. (3H,3C)

4154: ADVANCED BUILDING STRUCTURES II
Study of highrise structures ranging from building slabs and blocks, terraced buildings, and skyscrapers to towers. The complexity of load action including wind, earthquake, and hidden loads. The effect of building height, form, and proportion on force action; considerations of stability and redundancy. Preliminary design of masonry buildings, core structures, suspension buildings, braced skeletons, rigid frames, interstitial systems, staggered truss buildings, tubes and hybrid structures. Pre: 4075, 4076. (3H,3C)

4164: COMPUTER APPLICATIONS IN DESIGN
Computer system fundamentals. Very brief introduction to assembly programming. Programming in a high level language. Construction of a simple text editor. Construction of a simple relational file. Computer graphics fundamentals. Geometric transformations. 3-space geometry and projections. (3H,3C)

4204: URBAN TECHNOLOGY AND ARCHITECTURE
Architecture as determinant of urban spaces and urban form; perceptual, morphological, and typological characteristics of urban spaces as expressions of social values, ideals, and technological innovation. Theoretical models of technological, function, environmental, and social determinants of urban configurations are related to their cultural and historic precedents. X-grade allowed. (3H,3C)

4214: TOPICS IN ARCHITECTURE HISTORY AND THEORY
Topics in the history of architecture and theory, predominantly with reference to the Western World. Special emphasis on methods of analysis and interpretation. Repeatable with a maximum of 9C. X-grade allowed. Pre: 3115, 3116. (3H,3C)

4304: TOPICS IN DESIGN METHODS
Topics in systematic methods of design and the nature of the design process including application of

creative techniques, analogous thinking, analytic methods, computer-aided procedures, and information handling in design. Repeatable with a maximum of 6 credits. X-grade allowed. (3H,3C)

4414: ADVANCED ENVIRONMENT BUILDING SYSTEMS
Advanced studies of environment and building systems, including development in building systems, urban systems, service systems, construction systems, materials and component systems, psycho-physical considerations, systems analysis, and computer technology. May be repeated for a maximum of 9 credit hours in varied options offered. X-grade allowed. Pre: 4055, 4056. (2H,3L,3C)

4515-4516: ARCHITECTURE V
Advanced independent architectural research requiring articulation of a conceptual and professional position. This position is realized in a terminal thesis project completed in the second semester of the fifth year. X-grade allowed. Pre: 4016 for 4515; 4515 for 4516. 4515: (2H,20L,9C) 4516: (2H,16L,6C)

4524: THESIS DOCUMENTATION
During the second semester of the fifth year, the student takes a required three hour thesis documentation course where their conceptual and professional position is defined and tested by the documentation of the terminal architectural project. Pre: 4515. Co: 4516. (3H,3C)

4705-4706: QUALIFYING DESIGN SEMINAR
Exploratory overview of selected theories and issues relevant to the design and use of the environment. 4705: Emphasis on history, human behavior, and environmental context as it relates to architecture. 4706: Presentation and discussion of the nature of principal construction materials in relation to building design. Characteristics of primary structural materials: wood, steel, concrete, masonry; environmental control systems; supporting technologies. Not for credit for majors holding a first professional degree in architecture. (3H,3C)

4715-4716: QUALIFYING DESIGN LABORATORY
4715: Design laboratory in which student and faculty teams explore the nature of problems and potentials with which architecture is concerned, and experimentally develop methods and process through which existing contexts are transformed into new conditions. 4716: Provides introduction to basic concepts of building structures, materials, and enclosure systems, and appropriate site and climate responses. Not for credit for majors holding a first professional degree in architecture. X-grade allowed. (3H,18L,9C)

4904: PROFESSIONAL STUDIES
Pass/Fail only. X-grade allowed. (1H,1C)

4944: CONSORTIUM STUDIES IN ARCH
International consortium of Schools of Architecture. Undergraduate students are provided an academic environment utilizing the Washington D.C. metropolitan area as an educational laboratory for pursuit of architecture, landscape architecture and urban design and planning. Consortium studies courses are not for credit but reflect enrollment as a full time student. Approval for participation required by student home institution and Virginia Tech. Special fees apply. (0C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Air Force ROTC

Head: Eric S. Dorminey, Col., USAF
Professor: Eric S. Dorminey
Assistant Professors: L. J. Adams, B. J. Burton, I. A. Chelsey, J. W. Drinkard, and B. N. Pruitt
Recruiting Officer: L. J. Adams (231-8023)
Administrative Assistant: Connie Moses (231-6404)

Web: **www.af.vt.edu**

Overview

The Air Force Reserve Officer Training Corps (AFROTC) provides a program of leadership development which prepares college men and women for service as commissioned officers in the United States Air Force. After graduation, they assume active duty positions in both flying and non-flying specialties. To accomplish this, the Department of Aerospace Studies recruits, selects, retains, and commissions officer candidates as second lieutenants in the United States Air Force. AFROTC:

- Provides ethics and values education, stressing the Air Force core values of integrity first, service before self, and excellence in all we do.
- Prepares cadets to be commissioned as second lieutenants through a curriculum which develops leadership and management skills and provides opportunities to use these skills in a variety of practical applications.
- Provides an understanding of how to lead and influence small organizations, with a strong emphasis

on personal integrity, honor, and individual responsibility. The techniques of effective leadership and quality management are stressed to achieve mission accomplishment.
- Enhances the cadets' understanding of the role of the military in society and provides an in-depth orientation to history and tradition of the Air Force and how the Air Force serves the nation. This goal is reinforced by summer hands-on leadership training and career orientation opportunities at Air Force bases around the country.
- In conjunction with the Virginia Tech Corps of Cadets, provides programs and experiences which increase self-confidence, self-discipline, accountability, physical stamina, poise, and other traits essential to the development of a leader of character who is prepared to serve the nation or the commonwealth both in and out of uniform.

The curriculum and leader development programs of the Department of Aerospace Studies are mentally and physically challenging. Cadets learn basic military skills and participate in a demanding physical conditioning program starting in the freshman year. The program moves progressively from followership to leadership experiences and culminates with the senior class cadets planning, organizing, and administering all leadership training for the cadet group. On-campus instruction is conducted both in the classroom by Air Force officers and in the field environment by both officer and cadet leaders. Semiannual visits to Air Force bases expand the cadets' knowledge of Air Force operations and life-style. A demanding summer field training encampment prior to the junior year prepares the cadet for acceptance into the commissioning track.

Air Force ROTC offers four-, and three-year tracks. Four- and three-year track cadets must complete 8 semester hours of AFROTC academics prior to a two-week summer encampment. Students who have Junior ROTC, other-service ROTC, national guard, reserve, or active duty military experience may request credit and advanced placement.

Scholarships

Air Force ROTC offers four-, three-, and two-year scholarships which are based on merit, not need. Though scholarship awards vary, most pay all/partial tuition, books, and approved university fees. High school seniors who are interested in the four-year or guaranteed three-year scholarships must apply at **https://www.afrotc.com** by February 1 of their senior year. Non-scholarship cadets may apply for three- and two-year scholarships during their freshman and sophomore years. All students who are contracted into the AFROTC program (includes all scholarship winners and those juniors and seniors holding a commissioning contract) receive a tax-free stipend of up to $500 per month while in school.

Virginia Tech requires membership in the Virginia Tech Corps of Cadets to be enrolled in ROTC. All freshman and sophomore cadets maintaining Air Force standards, as well as contracted junior and senior cadets, receive a special Air Force uniform allowance to offset the cost of cadet uniforms. The Corps of Cadets also provides need- and merit-based scholarships for deserving cadets.

Completion of Air Force ROTC may qualify a student to receive a minor in leadership and service from the College of Liberal Arts and Human Sciences.

Air Force ROTC builds leaders and offers every student who successfully completes the program a job upon graduation. The basic requirements for commissioning are: award of a degree from Virginia Tech including a minimum of 24 hours of AFROTC; be a U.S. citizen of good moral character; meet medical and physical standards; achieve passing scores on the Air Force Officer Qualifying Test; and willingly accept a four-year active duty service commitment.

Undergraduate Course Descriptions (AS)

1115-1116: INTRODUCTION TO THE AIR FORCE
Introduction to the United States Air Force and Air Force Reserve Officer Training Corps. Mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and introduction to communication skills. Co: 2944 for 1115. (1H,1C)

2115-2116: THE DEVELOPMENT OF AIR POWER
Study of air power from balloons through the jet age. Historical review of air power employment. Evolution of air power concepts and doctrine. Air Force communication skills Pre: 1115, 1116. Co: 2944 for 2115. (1H,1C)

2934: AIR FORCE FITNESS
Reflects change in culture on physical fitness and incorporates fitness as a way of life with the United States Air Force & the Air Force Reserve Officer Training Corps (AFROTC). Structured to motivate members to develop and maintain year-round physical fitness conditioning program emphasizing total-body wellness to meet expeditionary mission requirements. Prepares cadets to tackle squadron fitness programs upon entering active duty. Course may be taken up to 10 times. Pre-requisite: Enrollment on AFROTC Co: 2944. (2H,1C)

2944: AFROTC LEADERSHIP LABORATORY
Experiential learning laboratory that allows cadets to practice and demonstrate mastery of leadership skills essential to an Air Force officer. May be taken eight times. Membership in Virginia Tech Corps of Cadets required. Pass/Fail only. Co: 1115, 1116, 2115, 4216, 3215, 3216, 4215, 2116. (4L,1C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3215-3216: AIR FORCE MANAGEMENT AND LEADERSHIP
Integrated leadership study emphasizing concepts and skills. Motivational and behavioral processes, management, military ethics, communication, and group dynamics. Examines case studies and scenarios. Pre: 2116. Co: 2944 for 3215. (3H,3C)

4215-4216: NATIONAL SECURITY FORCES IN CONTEMPORARY AMERICAN SOCIETY
Examines the formulation, organization, and implementation of national security; evolution of strategy; management of conflict; and civil-military interaction. Military profession, officership, and the military justice system. Air Force communication skills. Pre: 3216. Co: 2944 for 4215. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

Agricultural Technology - Associate Degree Program

Director: P. Mykerezi, Ph.D.
Senior Instructors*: S. Doak, R. Kohl, T. Martin, and J. Guthrie
Instructor: W. Gwaltney
Undergraduate Program Directors: S. Doak and R. Kohl

* In addition, selected faculty members from departments within the College of Agriculture and Life Sciences teach courses in the program.

Overview

The Agricultural Technology Program offers a concentrated academic experience for individuals pursuing an associate degree in preparation for careers in the agriculture and green industries. Students can specialize in Applied Agricultural Management or Landscape and Turfgrass Management.

Applied Agricultural Management (AAM)

- Animal Science
- Crop Science
- Agribusiness

The AAM specialty provides students with a balanced education – including courses in livestock production, crop production, and agribusiness – that prepares them for diverse job opportunities.

The animal science curriculum includes courses in genetics, nutrition, reproduction, health, and management. It focuses on the biological and economic aspects of animal production and management. Soils, forages, mechanics and chemical application courses round out the AAM curriculum.

Business courses provide instruction in financial recordkeeping, professional selling, personnel management, strategic marketing, whole business planning, and information systems, focusing on strategic management and economic issues of the agricultural industry. Laboratories stress the use of modern management methods and computer applications for problem solving.

The crop science curriculum provides students knowledge and hands-on experiences relative to Virginia's major crop and forage systems. Students learn about cash crop rotations and grazing management as well as precision agriculture, integrated pest management, pesticide application, and pesticide safety. Students gain experience using the latest technologies in precision agriculture through labs held in partnership with leaders from the farm equipment industry.

Landscape and Turf Management (LTM)

- Golf Course Management
- Landscape Management
- Sports Turf Management
- Horticulture Production

In the LTM specialty, students prepare for a career in the green industry — including landscape design, landscape contracting, golf course management, horticulture production and nursery management, and sports turf management. They learn about turfgrass and landscape installation, maintenance, and management.

The LTM curriculum focuses on developing well-rounded students who are in high demand by many branches of the green industry. Students learn about various types of plants, turfgrass management, soils and nutrient management, landscape design, and Irrigation and drainage.

Additional courses are offered in horticulture production, hardscaping, landscape contracting, golf and sports turf management, integrated pest management, and chemical application. Special study classes allow students to work on the Virginia Tech golf course and athletic fields and compete in national competitions. A strong core of business courses is also offered. Laboratories for each class focus on hands-on learning and expose students to a range of applied landscape and turf management skills.

Course Requirements for Major

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

All students are required to complete an occupational internship for academic credit to provide practical experience in a work environment. The three-credit internship lasts for 10 weeks and 400 hours. The internship usually occurs during the summer between the first and second year of the program. Students, in consultation with faculty members, select their own internships that may be located anywhere in the

United States or abroad.

All admission offers for this program are made though the Agricultural Technology Program. Foreign language is not a requirement of this program. Recommended high school courses include English, Algebra I and Geometry (minimum), a lab science, and a computer class. Students are encouraged to pursue an Advanced or Standard Diploma from high school. Agricultural Technology students have the same rights and privileges as other students at Virginia Tech, except for membership in the Corps of Cadets and participation in NCAA sports. Selected agricultural technology courses can be transferred to a bachelor's degree program in the College of Agriculture and Life Sciences at Virginia Tech. Bachelor degree students are not permitted to enroll in Agricultural Technology courses.

Satisfactory Progress towards Degree

Students must achieve and maintain a cumulative 2.00 GPA each semester;

All AT courses will be used in the calculation of the GPA.

Undergraduate Course Descriptions (AT)

0104: COMPUTER APPLICATIONS IN THE AGRICULTURAL INDUSTRY
Provides a basic understanding of the operation and use of the micro-computer for farm/firm business management. Stresses the practical applications of Microsoft Office (word processing, spreadsheets, and database management systems, PowerPoint, and Outlook), Adobe Acrobat including PDF Annotator, and OneNote to agricultural production and financial management decisions. (2H,3L,3C)

0114: APPLIED AGRICULTURE MATHEMATICS
This course will provide students with a background in the mathematical methods and operations used to solve numerical problems arising in soils, dairy, horticulture, landscape, poultry, turf, crops, livestock and feeds. Students will become acquainted with terminology and equations unique to agricultural businesses and enterprises. Emphasis is placed on solving word problems. (3H,3C)

0124: AGRICULTURAL MACHINERY & MECHANICS
Introduction to the operation and maintenance of internal combustion engines, field machinery, tractor and power units, and shop to include the fundamentals of gas and arc welding. (2H,3L,3C)

0144: COMMUNICATION SKILLS
Written and oral communication skills, including business and technical writing, public speaking, and interpersonal communication. Instruction and practice in the application of communication skills for business and agriculture. Emphasis on effective use of word processing and email software. (3H,2L,4C)

0164: INTRODUCTION TO ANIMAL SCIENCE
Study of animal products, production methods, and management systems for beef, sheep, horses, dairy, swine and poultry. Classroom instruction, demonstrations, and hands-on experience with livestock and poultry. (3H,3L,4C)

0174: FUNDAMENTALS OF TURFGRASS MANAGEMENT
Turfgrass identification, morphology, adaptations, and management systems for parks, lawns, athletic fields, roadsides, and golf courses. Mowing, irrigation, fertilization, soil management, pest management, and other practices that impact turf management. Turfgrass management planning utilizing Integrated Pest Management and Best Management Practices. (3H,3L,4C)

0184: INTRODUCTION TO PLANT BIOLOGY AND CHEMISTRY
Basic botanical and chemical principles and their applications to sound plant production and management practices. Emphasis on practical experiences in laboratory and field settings. (2H,2L,3C)

0194: AGRICULTURAL TECHNOLOGY INTERNSHIP
Practical experience in a selected agricultural enterprise, under the direct supervision of owner, manager,

or supervisor. Internship will be evaluated by faculty member. Written reports of work experience activities are required. Completion of at least 28 credits with a minimum GPA of 2.00 required. Variable credit course. X-grade allowed.

0224: PERSONNEL MANAGEMENT
Principles and practices in the recruitment, selection, and compensation of employees. Emphasis on employer/employee relationships, including incentive programs. Impacts of safety and environmental concerns on the health and well-being of agricultural employees. (1H,2L,2C)

0234: INTRODUCTION TO AGRIBUSINESS AND FINANCIAL MANAGEMENT
Functions of agribusiness enterprises within the U.S. economic framework. Economic systems, cooperatives, essential elements of business organization, management tools for decision-making, creating financial statements, business planning, development and analysis of budgets, investing in a business, and time value of money. (2H,3L,3C)

0254: ANIMAL STRUCTURES AND ENVIRONMENTS
Functional considerations in facilities development for production agriculture. Concepts of farmstead planning and system development emphasized. Techniques for providing production animal environment, especially for confinement facilities. Pre: 0114. (3H,3C)

0274: STRATEGIC AGRIBUSINESS MARKETING AND ENTREPRENEURSHIP
Principles of marketing through the agribusiness industry including the strategic management of products, distribution, promotion, and pricing to improve business performance. Entrepreneurship is explored as a career alternative including methods for acquiring necessary start-up capital. Solving business problems utilizing finance and marketing tools. (2H,2L,3C)

0284: PROFESSIONAL SELLING FOR AGRIBUSINESS
Fundamentals of professional selling in the agricultural environment. Preparing and making sales presentations for an agricultural product. Safety and environmental concerns associated with the purchase and/or use of an agricultural product or service. (1H,2L,2C)

0294: LIVESTOCK MERCHANDISING
A comprehensive study of the principles and activities involved in successfully promoting and merchandising livestock. A livestock auction will be held at the conclusion of the course to provide experiences in advertising, salesmanship, facility development, sale management, and budgeting. Pre: Second year student. (2H,2C)

0304: MEATS AND ANIMAL PRODUCTS EVALUATION AND PROCESSING
Principles and applications of the evaluation and utilization of animal products of beef, pork, lamb, poultry and dairy origin with emphasis on the conversion of live animals to retail cuts and processed meats and milk into dairy products. (6L,2C)

0324: LIVESTOCK REPRODUCTION
Principles and practices of reproductive management used to maximize reproductive efficiency in dairy and beef cattle, sheep, swine, and horses. Must be second year student in Agriculture Technology. Pre: 0164. (1H,2L,2C)

0334: PRINCIPLES OF ANIMAL HEALTH
A general introduction to animal health principles of farm animal species, intended to provide an understanding of the fundamentals of disease processes and animal healthcare. The emphasis is on disease prevention and control rather than on the treatment of disease. Must be second year student in Agriculture Technology. (2H,3L,3C)

0344: GRAIN CROP MANAGEMENT
Principles and practices of efficient grain crop management with an emphasis on Virginia cropping systems. Pre: 0184, 0414. (3H,3L,4C)

0354: FEEDS AND FEEDING
Principles and practices of livestock feeding. Anatomy and physiology of ruminant and non-ruminant

digestive systems. Emphasis on nutrient requirements and ration formulation. Computerized ration formulation and evaluation. (1H,2L,2C)

0364: ATHLETIC FIELD PRACTICUM - FOOTBALL/SOCCER
Learn the principles and techniques of game preparation and routine maintenance on the NCAA football and soccer fields at Virginia Tech. Students' laboratory experience will be field work with the Virginia Tech Athletic Department staff. Focusing the football and soccer fields during the NCAA competition season. (6L,2C)

0374: ATHLETIC FIELD PRACTICUM - BASEBALL/SOFTBALL
Learning the principles and techniques of game preparation and routine maintenance on the NCAA baseball and softball fields at Virginia Tech. Students' laboratory experience will be field work with the Virginia Tech Athletic Department Staff. Focusing on the baseball and softball fields during the NCAA competition season. (6L,2C)

0394: GOLF COURSE PRACTICUM
Principles and techniques of golf course preparation and maintenance required for a high-end golf course. Off-site fieldwork, laboratory experience. Practice maintenance procedures needed to rejuvenate the golf course from the summer season. Pre: 0174. (6L,2C)

0404: IRRIGATION AND DRAINAGE
Principles applied to solving irrigation and drainage problems. Emphasis placed on hydraulics, irrigation design, irrigation scheduling, and components including heads, valves, controllers, backflow prevention, wire, pipe, and fittings. Co: 0114. (2H,2L,3C)

0414: SOILS AND NUTRIENT MANAGEMENT
Physical, chemical, and biological properties of soils; soils' suitability for production of a range of agricultural crops to include turfgrass and landscape plants. Properties of common liming, biosolid, manure, and fertilizer materials with emphasis on their environmental impacts. Soil and plant sampling procedures and the analysis of soil tests. Nutrient management plans. (2H,2L,3C)

0434: PEST MANAGEMENT: INSECTS, DISEASES, AND WEEDS
Identification, classification, and life cycles of economically important insects, plant pathogens, and weeds. Pest management methods: cultural practices, chemical control, biological control, host plant resistance, etc. (3H,3L,4C)

0444: COMPUTER-AIDED DRAFTING FOR LANDSCAPING
In-depth study and hands-on experience essential to landscape horticulture graphics in a digital format using industry appropriate software. Pre: 0684. (1H,3L,2C)

0464: FORAGES AND FORAGE ANIMAL SYSTEMS
use of cool-season and warm-season forage species currently grown in Virginia in forage-based animal systems. Pre: 0184, 0414. (3H,3L,4C)

0484: PRECISION AGRICULTURE AND DATA MANAGEMENT
Introduction to various tools and applications related to precision agriculture. Collection, analysis, and effective interpretation and utilization of precision agriculture data, including soil test data, precision fertilizer, and pesticide data. Pre: 0184, 0344. (2H,2C)

0494: DAIRY MANAGEMENT
Concepts of efficient and profitable management of modern dairy herds. Application of basic principles of business, milking, mastitis control, milk quality, herd replacements, feeding, breeding, reproduction, herd health, housing, and milk marketing management to profitable dairy farming. (2H,3L,3C)

0504: AGRICULTURAL TECHNOLOGY SURVEY
Orientation to the Agricultural Technology program and resources available at Virginia Tech. Introduction to state, national, and international agriculture; internship requirements; and opportunities and careers in agriculture. (1H,1C)

0514: CONTEMPORARY AGRICULTURAL ISSUES
A survey course designed to acquaint the student with the concerns and critical issues impacting the field of agriculture. Contemporary agricultural issues will be explored. (3H,3C)

0524: WHOLE FARM PLANNING
Principles of whole farm and agricultural business planning including creating business plans, personal financial plans, and farm/business transition plans. Identifying and solving real-world agribusiness problems utilizing proper planning. Pre: 0234. (2H,2C)

0544: HORTICULTURE PRODUCTION
Production of vegetable, fruit, flowering, and nursery crops, including propagation of these crops. Focus is on the culture of these commodities as alternative agricultural crops, including environmental and cultural requirements for high quality production. (2H,2L,3C)

0554: CHEMICAL APPLICATION
Proper application of pesticides and other agricultural chemicals used in landscape and turf management and in production agriculture; including application methods, equipment calibration and configuration, occupational health and safety, and pesticide laws and regulations. (1H,2L,2C)

0564: HERBACEOUS PLANTS
Identification, selection, requirements, and uses of herbaceous plant materials commonly found in landscapes; includes annuals, perennials, bulbs, and grasses. (1H,2L,2C)

0574: WOODY LANDSCAPE PLANTS
Identification and uses of evergreen and deciduous woody plant materials common in the landscape industry; including trees, shrubs, and ground covers; proper plant selection and location in the landscape site. (1H,3L,2C)

0614: BEEF AND SHEEP MANAGEMENT
Beef cattle/sheep production and management. Emphasis on genetics, nutrition, herd health, reproduction, and marketing to optimize performance and profit. Management and flock decisions based on economic and business principles. Practical experience enhanced through laboratory activities. Pre: 0164. (2H,3L,3C)

0624: HORSE MANAGEMENT
Horse production and management. Emphasis on genetics, nutrition, herd health, reproduction, and marketing to optimize performance and profit. Management decisions based on economic and business principles. Practical experience enhanced through laboratory activities. (2H,3L,3C)

0654: GOLF COURSE DESIGN AND RULES
Principles of golf course design and rules of the game, including: evolution, fairness, progression, hazards, shot value, and safety. The United States Golf Association’s rules of golf will be covered. (2H,2C)

0664: GOLF AND SPORTS TURF MANAGEMENT
Management of turfgrass on modified soil. Advanced management techniques and manipulation of nutrition and cultural practices to reduce plant stress or increase plant tolerance. Intensive turfgrass pest identification, life cycles, environmental conditions, and methods of effective control. Integrated pest management and best management practices. Pre: 0174. (2H,2L,3C)

0674: SPANISH FOR THE GREEN INDUSTRY
Dialogue-based language skills focused on vocabulary and grammatical structures common to agricultural and green industries. Includes vocabulary and contexts specific to activities in greenhouse, nursery, turf, and landscape environments. Elements of Spanish culture are included throughout the course. Pre: Prior study in Spanish is helpful but not required. (3H,3C)

0684: LANDSCAPE DESIGN
Principles and practices involved in the development and interpretation of landscape designs; proper selection and use of landscape construction materials and methods of construction. Introduction to

utilizing computer-aided drafting. Pre: 0564. Co: 0574. (2H,3L,3C)

0694: LANDSCAPE CONTRACTING
Interpreting a landscape design and properly installing plant materials. Preparing bids for customers using cost accounting principles. Maintaining and renovating landscapes as well as exploring careers and business opportunities in the landscaping industry. Pre: 0564, 0574. (2H,3L,3C)

0704: TURFGRASS CAPSTONE PROJECT
Capstone course for the Landscape Turfgrass Management option of the Agricultural Technology program. Problem based learning course to evaluate selected turfgrass problems for stakeholders such as golf courses, athletic fields and parks and recreation departments' facility administrators. Students to look holistically at a problem and use critical thinking, experiences and knowledge from previous class work to create custom solutions. For second-year students only. Pre: 0664. (1H,4L,3C)

0714: HARDSCAPE MATERIALS AND INSTALLATION
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction. Restricted to students in the Landscape & Turf Management option in the Agricultural Technology Program. (6L,2C)

0724: LANDSCAPE SKILLS PRACTICUM
This course provide an introduction to a multitude of skills that are important for success in the landscape industry. Each session is set in a competitive environment emphasizing the development of a selection of hands-on skills, including safe equipment operation, landscape and hardscape installation, management and estimating techniques, and arboculture methods. (2L,1C)

0734: RISK MANAGEMENT IN AGRICULTURE
Fundamentals of managing risk in agriculture, particularly for production of row crops and livestock, including sources of risk and cost/benefit analysis of various risk mitigation strategies. Commodity futures contracts and options as price risk management tools. Government policies, particularly crop and livestock insurance provisions of the current Farm Bill. Co: 0234. (2H,2C)

0904H: HONORS SEMINAR IN AGRICULTURAL TECHNOLOGY
Exploration of topics in agriculture and related fields that impact and effective and efficient agricultural industry, including professional leadership skills. Special attention will be given to the collaboration and interdependency that the field of agriculture has with other segments of society, including social, political, and economics areas. May be repeated for a maximum of 3 credits and with different topics. (1H,1C)

0974: INDEPENDENT STUDY
Variable credit course.

0984: SPECIAL STUDY
Variable credit course.

Building Construction

Head: A. P. McCoy
Professors: Y.J. Beliveau, A. P. McCoy, W.Y. Thabet
Associate Professors: T. Bulbul, T. H. Mills, A.R. Pearce, G. Reichard
Assistant Professor: N. Roofigari-Esfahan
Professor of Practice: S. Haas
Assistant Professor of Practice: A. Graff

Web: **www.bc.vt.edu**

Overview

The Building Construction curriculum focuses on the business and process of making buildings and is designed to better equip construction industry professionals with the necessary tools for excellence in all phases of the built environment. The building construction degree incorporates business, management, science and efficiency at all levels; from planning, finance, design, estimating, procurement, and scheduling. The curriculum additionally includes integrative elements of leadership, non-technical social and presentation skills, entrepreneurship, and best principles.

The Building Construction program develops within the student a solid foundation in construction knowledge.

The Building Construction major is accredited by the American Council for Construction Education. Upon successful completion of the four-year program of 134 credit hours of study, a Bachelor of Science in Building Construction is awarded.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (BC)

1214: INTRODUCTION TO BUILDING CONSTRUCTION I
This is an introduction to the world of construction with an overview of the important areas of contracting and the inter-workings of the construction industry. Emphasis is placed on the theory and terminology of the construction industry supplemented with the graphical representation of construction documents and laboratory building experiments. (2H,3L,3C)

1224: INTRODUCTION TO BUILDING CONSTRUCTION II
Continuation of introduction to the world of construction with an overview of the important areas of contracting and the workings of the construction industry. Emphasis is placed on the application of theory, processes and vocabulary of the construction industry supplemented with computer aided graphical representation of construction documents. Grade of C- or better required in prerequisite. Pre: 1214. (2H,3L,3C)

2014: CONSTRUCTION PRINCIPLES I
Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards. Pre: 1224. (2H,3L,3C)

2024: CONSTRUCTION PRINCIPLES II
Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression. Pre: 1224, 1214, 2014 or 4264. Co: 2064. (3H,3C)

2044: BUILDINGS & MATERIALS
Introduction to the theory and applications of building materials. Properties, composition, and characteristics of building materials with particular focus on ferrous and non ferrous metals, concrete, bricks and blocks, timber, glass and plastics. Emphasis on physical behavior of materials under load, including thermal loads, compatibility deformations and material behavior requirements, interaction among different materials, non-destructive/destructive methods for evaluation and testing of construction materials, basic analysis and design applications of major structural components. Pre: 2214 or CNST 2104 or CEM 2104. (2H,3L,3C)

2064: INTEGRATED CONSTRUCTION I
Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected

project. Project cost impact of building code requirements. Emphasis on structural components of selected project. Pre: 2014. (3H,3C)

2094: BUILDING CONSTRUCTION SEMINAR
Exploration of current and relevant topics of inquiry within the construction domain, through engagement, service, and research. Articulates the complex interactions of stakeholders in construction by means of reflection on case studies, panel discussions, and seminars to establish the context, breadth, and impact that construction education shares within larger academic, professional, and societal communities. Can be repeated for a maximum of 3 credit hours. Pass/Fail only. (1H,1C)

2104: BUILDING EFFECTIVE CONSTRUCTION TEAMS
Introduction to tools and techniques to help build effective construction teams including building trust, managing conflict, communicating clear expectations and priorities, accountability, attention to results and commitment towards construction management team mission, embracing innovative change and ethics. Other topics include networking skills, time management tools and effective construction team-based negotiations. Pre: (1224 or 4264), (COMM 1016 or ENGL 1106). (3H,3C)

2114: INFORMATION TECHNOLOGY IN DESIGN AND CONSTRUCTION
Building delivery and project management improvements through the use of computer applications are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts the integrate design and construction. Pre: 1224 or CNST 2104 or CEM 2104. Co: 2014. (2H,3L,3C)

2214: WHY BUILDINGS STAND UP
Addresses why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Explores different types of soils and their strength properties. Pre: MATH 1225 or MATH 1025. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3014: BUILDING PHYSICS & ENVIRONMENTAL SYSTEMS
Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems. Pre: PHYS 2305. (2H,3L,3C)

3064: INTEGRATED CONSTRUCTION II
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project. Pre: 2064. (3H,3C)

3114: BUILDING SYSTEMS TECHNOLOGY
Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads. Pre: (2024 or CNST 2104 or CEM 2104), PHYS 2305. (2H,3L,3C)

3134 (CEM 3134) (CNST 3134): TEMPORARY STRUCTURES IN CONSTRUCTION
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts. Pre: (2044, 2024) or CEE 3684. (3H,3C)

3954: STUDY ABROAD

Study abroad in Spain. Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4024 (CEE 4014): ESTIMATING, PRODUCTION, AND COST ENGINEERING
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures. Pre: 2024, 2064. (3H,3C)

4064: INTEGRATED CONSTRUCTION III
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project. Pre: 3064. (3H,3C)

4114: BUILDING INFORMATION MODELING IN DESIGN AND CONSTRUCTION
Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming. Pre: 2114. (3H,3C)

4124: DIGITAL CONSTRUCTION & MANUFACTURING
Explore and experiment with construction from the perspective of digital information, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Tools like 3D scanners, 3D printers, CNC manufacturing techniques and others will be used in a lab setting intended to provide familiarity with these technologies and a sense of their benefits and limitations. Pre: 2114. (2H,3L,3C)

4164: PRODUCTION PLANNING AND PROCESS DESIGN FOR CONSTRUCTION
The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction. Pre: 3114, 3064. (3H,3C)

4264: FUNDAMENTALS OF CONSTRUCTION MANAGEMENT
Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing. (6H,6C)

4314: BUILDING PERFORMANCE & ENERGY MANAGEMENT
Fundamentals of building performance mandates for the built environment, practical means and methods for evaluating building performance metrics. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle. Pre: 3014. (2H,3L,3C)

4324: INNOVATION IN RESIDENTIAL CONSTRUCTION
Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry. Pre: 2024, 3114. (3H,3C)

4334: SUSTAINABLE BUILDING PERFORMANCE MANAGEMENT
Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning. Pre: 3064, 3014. (3H,3C)

4374: RESIDENTIAL HOUSING AND LAND DEVELOPMENT
Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing. Pre: 2064, 3064. Co: 4064. (3H,3C)

4434: CONSTRUCTION PRACTICE I
Business and construction practices related to operation of a construction company are studied. Construction operation is examined as it relates construction, financial and personnel management. Project management topics studied in this course include permitting, site evaluations, design development and design phase considerations such as preliminary estimates and project constructability. Writing Intensive (WI) course. Pre: (2044, 3064) or 5264G or (5114, 5154) or CEM 2104. Co: 4064. (3H,3C)

4444: CONSTRUCTION PRACTICE II
This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals. Pre: 4434. (3H,3L,4C)

4754: INTERNSHIP
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Biochemistry

Head: G. E. Gillaspy
Professors: D. R. Bevan, D. R. Dean, G. E. Gillaspy, P. J. Kennelly, T. J. Larson, J. Li, B. Mukhopadhyay, P. Sobrado, Z. Tu, and J. Zhu
Associate Professors: R. F. Helm, M. W. Klemba, and R. H. White
Assistant Professors: K. D. Allen, B. J. Jutras, J. Lemkul, Z. B. Mackey, D. Slade, C. Vinauger, and B. Xu
Research Assistant Professors: C. Lahondere and E. Purwanti
Collegiate Professors: K. Hite, S. Marine, and C. Thorpe
Adjunct Faculty: D. Capelluto, B. Costa, C. Finkielstein, D. Good, D. Kelly, J. Mahaney, and D. Tholl
Career Advisor: P. J. Kennelly (231-4317) pjkennel@vt.edu
Academic Support Advisor: A. Rasor (231-8734) arasor@vt.edu
Undergraduate Coordinator: D. R. Bevan (231-5040) drbevan@vt.edu
Undergraduate Lab Coordinator: T. J. Larson (231-7060) tilarson@vt.edu

Web: **www.biochem.vt.edu**

Overview

The Bachelor of Science in biochemistry is designed to provide students with a thorough foundation in chemistry and biology and an appreciation of how these sciences are integrated to explore the molecular mechanisms underlying biological processes. The plan of study prepares students for careers in medicine, veterinary medicine, biomedical research, agriculture, industrial biochemistry, or biotechnology. In addition, it provides the background for post-graduate studies in the life sciences or professional studies in medicine, nursing, veterinary medicine, dentistry, pharmacy, and clinical chemistry.

The department offers the undergraduate biochemistry degree in two colleges, the College of Agriculture and Life Sciences and the College of Science. Biochemistry majors complete the Curriculum for Liberal Education requirements unique to the college in which they are enrolled.

The departmental requirements for majors in either college are: mathematics (9-12 credits); physics (8 credits); principles of biology (8 credits); genetics (3 credits); general microbiology (4 credits); general chemistry (8 credits); organic chemistry (8 credits); physical chemistry (6 credits); analytical chemistry (4 credits); introduction to biochemistry (1 credit); biochemical calculations (2 credits) ; general biochemistry (7 credits); and laboratory problems in biochemistry and molecular biology (6 credits).

To qualify for a major in biochemistry, the department requires that students maintain a minimum 2.0 grade point average (GPA) for the hours passed in all required biochemistry, biology, and chemistry courses. In addition, the department requires that a student earn a C- or better in all required biochemistry, chemistry, and biology courses.

The plan of study allows time for qualified students to participate in undergraduate research (BCHM 4994). Qualified students are strongly encouraged to initiate research activity prior to their senior year. A minimum GPA of 2.5 is required for enrollment in BCHM 4994. Students participating in undergraduate research are encouraged to present a senior thesis.

Upper-division students who qualify for the Honors Program may participate in the "in honors" degree program in biochemistry. The Honors Program and undergraduate research program include study and research with individual faculty members.

Biochemistry majors may participate in the Cooperative Education Program that alternates academic study with employment experience. Additional information pertaining to the CO-OP program is included in the "General Information" section of this catalog. Summer internships with various businesses and governmental agencies are frequently available, particularly to rising seniors.

Bioinformatics/Genomics

The department supports students' interest in bioinformatics/genomics by providing instruction and laboratory experience in those areas. Students are advised of appropriate supporting courses in computer science that may be used toward a minor in Computer Science.

The department also offers a graduate program leading to the M.S. and Ph.D.

The minimum number of credits required for the B.S. in Biochemistry is 120.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Biochemistry.

Satisfactory progress requirements toward the B.S. in Biochemistry in both the College of Agriculture and Life Sciences and in the College of Science can be found on their major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (BCHM)

1014: BIOCHEMISTRY FIRST YEAR EXPERIENCE
Applications of biochemistry in agricultural and life science disciplines; topical research areas in biochemistry; educational requirements and career opportunities for biochemistry majors; critical thinking and data interpretation in biochemistry. Pass/Fail only. (1H,1C)

1984: SPECIAL STUDY
Variable credit course.

2024: CONCEPTS OF BIOCHEMISTRY
Short course in fundamentals of the chemistry of living systems. Introduction to major categories of biochemical substances, metabolic pathways, and principles of biochemical information transfer. (No credit for majors). Pre: CHEM 2514 or CHEM 2535. (3H,3C)

2114: BIOCHEMICAL CALCULATIONS
Fundamental mathematical relationships in biochemistry. Calculations central to the investigation of biochemical phenomena including aqueous chemistry, spectrophotometry, enzyme kinetics and thermodynamics. Introduction to the core calculations used in experimental biochemistry and the strategies employed for solving biochemical problems. Pre: CHEM 2535 or CHEM 2565. (2H,2C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3114: BIOCHEMISTRY FOR BIOTECHNOLOGY AND THE LIFE SCIENCES
Survey presentation of the basic principles of biochemistry as they apply to biotechnology. Topics covered include protein structure, enzymology, cellular organization, and biochemical regulation. Special emphasis will be given to gene structure, transcription, and translation, cellular organization, and cloning, sequencing,

modification and expression of recombinant DNA. Examples will be given of agricultural/medical/industrial applications of cellular and molecular biochemical knowledge. Non-majors only. Pre: CHEM 2536 or CHEM 2566. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4054 (APSC 4054): GENOMICS
A contemporary analysis of the development, utility and application of high-resolution methods for the study and manipulation of the complete genomes of organisms. The use of new techniques for genomic, metabolic and protein engineering (functional genomics), including high-throughput methods and nanotechnology, will be emphasized. Pre: 3114 or 4116 or BIOL 3774. (3H,3C)

4074: CAREER ORIENTATION
Examination of various career opportunities for biochemists in industry, academia, medicine and related health sciences. Introduction to resources for locating career opportunities, resume preparation and interview skills. Restricted to biochemistry majors. Junior standing required. I Pass/Fail only. Co: 4115. (1H,1C)

4115-4116: GENERAL BIOCHEMISTRY
Metabolism and chemistry of carbohydrates, proteins, lipids, and nucleic acids with emphasis on interactions and comparative aspects of microbial, plant, and animal forms. For students in the biochemistry curriculum and other students interested in a foundation course. (Students are required to have at least a C- in both CHEM 2535 and 2536 to be admitted to BCHM 4115). Pre: (CHEM 2536 or CHEM 2566), (BCHM 2114 or CHEM 2154) for 4115; 4115 for 4116. 4115: (4H,4C) 4116: (3H,3C)

4124: LABORATORY PROBLEMS IN BIOCHEMISTRY AND MOLECULAR BIOLOGY
Presentation of major analytical techniques of importance to biochemistry and molecular biology, including spectrophotometry, electrophoresis, chromatography. Lab study of selected principles and methods used in biochemistry and molecular biology. Pre: 4115, (CHEM 2114, CHEM 2124) or (CHEM 3114, CHEM 3124). Co: 4116. (3H,9L,6C)

4354: BIOCHEMICAL COMMUNICATION
Exploration of how chemical signals are produced, transported, and influence microbes (Bacterial and unicellular organism (chemotaxis), plants, and animals (olfactory neuroethology). Applications to cell biology, neurobiology, and ecology. Analysis of the interaction between biochemical communication systems and health (diseases). Management, statistical analysis, and interpretation of large datasets related to biochemical communication, using computational approaches. Pre: (3114 or 4115), (STAT 2004 or STAT 3615). (3H,3C)

4754: INTERNSHIP
Variable credit course.

4784 (BIOL 4784): APPLICATIONS IN MOLECULAR LIFE SCIENCE
Synthesis and application of biochemistry, cell biology, genetics, genomics, physiology, immunology concepts and techniques to address medical and agricultural problems. Gene characterization and manipulation, protein-based drugs, diagnostics, vaccines, transgenic plants/animals. Analysis, critique, application of research in molecular life science. Pre: (3114, 3124, BIOL 3774, BIOL 4774) or (BCHM 4116, BCHM 4124). (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Biological Sciences

Head: Robert S. Cohen
Distinguished Professor: J. J. Tyson
Harold H. Bailey Endowed Chair: J. R. Walters
Professors: J. Barrett, L. K. Belden, D. Cimini, M. Fox, M. J. Friedlander, D. Hawley, R. Jensen, I. Lazar, L. Li, I. T. Moore, E. T. Nilsen, B. D. Opell, D. L. Popham, J. Phillips, B. Scharf, J. Sible, A. M. Stevens, D. Tholl, and B. S. J. Winkel
Associate Professors: B. Brown, C. Carey, D. Capelluto, V. Corbin, C. Finkielstein, S. Hauf, C. B. Lawrence, J. W. McGlothlin, S. B. Melville, F. Schubot, K. Sewall, R. A. Walker, and Z. Yang
Assistant Professors: F. Aylward, J. Chen, J. Draghi, E. R. Hotchkiss, C. N. Jones, S. Kojima, J. W. McGlothlin, M. C. Mims, J. Smyth, J. C. Uyeda, and S. R. Whitehead
Assistant Professors of Practice: L. A. Blanc, J. G. Tokuhisa
Instructors: M. M. Emori, J. Evans, E. P. Hogan, M. V. Lipscomb, M. S. Rosenzweig, R. W. Seyler, S. M. Voshell, and J. I. Watkinson

Web: **www.biol.vt.edu**

Overview

The Department of Biological Sciences offers two B.S. degree paths: the B.S. in Biological Sciences and the B.S. in Microbiology.

The B.S. in Biological Sciences program provides majors with a broad education in the study of life. This curriculum exposes students to the fundamentals of the discipline: genetics, cell and molecular biology, evolutionary biology, and ecology. In addition, Biological Sciences majors may take advantage of elective courses on topics such as macromolecular structure, pathogenic bacteriology, cancer biology, infectious disease ecology, human genetics, and global change ecology. Students may choose to complete an option in one of the following three areas: Biomedical; Ecology, Evolution, and Behavior (EEB); or Biology Education.

The B.S. in Microbiology program provides majors with a more focused education in the biology and roles of microscopic life forms present in our environments. The laboratory-intensive curriculum provides knowledge in the genetics and physiology common to all microbes and allows students to explore specific interests with a broad range of advanced electives such as pathogenic bacteriology, immunology, environmental microbiology, food microbiology, virology, microbial forensics, and bioinformatics.

Modern biology increasingly relies on knowledge, skills, and perspectives associated with other scientific fields, particularly chemistry, mathematics, physics and statistics. Success in biological sciences-associated careers requires students to master the fundamentals of these cognate fields and to be able to apply these skill sets.

As a scientific discipline, biology is more than simple knowledge about living organisms. By integrating education and research, our majors are training to be leaders in their field who practice innovative and interdisciplinary approaches in biological research. By participating in undergraduate research during the academic year, our students are discovering through hands-on experience what it means to Invent the Future. Our majors are strongly encouraged to explore internships and research opportunities on campus and elsewhere during the summer.

The majority of our graduates continue on to advanced studies in the health professions or in various branches of the biological sciences. Graduates pursue professional degrees in medicine, dentistry, veterinary medicine, pharmacy, and nursing, or M.S. or Ph.D. degrees in ecology, environmental biology,

microbiology, botany, zoology, cell biology, molecular biology, and biomedical sciences. Students interested in entering the workforce are provided the core background for opportunities in biotechnology, food science, bioinformatics, bio-business, and health-related industries.

Preparation for Advanced Study

Graduate Study

Students who satisfactorily complete the undergraduate curriculum in biological sciences or microbiology may pursue advanced studies leading to the M.S. or Ph.D. in various branches of the biological sciences. Those interested in teaching science are prepared to pursue the M.A.Ed.

Preparation for Medicine

The training afforded by the first three years (approximately 96 hours) meets the pre-medical training requirements of medical colleges that accept students with only three years of undergraduate work. It is strongly recommended, however, that all students complete a B.S. before entering medical school.

Preparation for Dentistry

Dental colleges require a minimum of three years of college training for admission, but it is generally advisable for students to complete the B.S. before entering dental school.

Preparation for Allied Health Professions

Schools of Allied Health Professions, such as nursing, pharmacy, medical technology, physical therapy, etc., require two or more years of college work for admission. Specific requirements are available from Career Services or the Biological Sciences Department.

Preparation for Veterinary Medicine

Veterinary schools require a minimum of three years of college training for admission. Few students who meet only the minimum entrance requirements are accepted by veterinary schools.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor Requirements

The requirements to earn a minor in Biology can be found on its checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet

minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Biological Sciences and the B.S. in Microbiology can be found on their major checksheets by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (BIOL)

1004: BIOLOGY ORIENTATION SEMINAR
An introduction to academic and career planning for majors in Biology and students who may be considering Biology as a major. (1H,1C)

1005,1006: GENERAL BIOLOGY
Primarily for those not majoring in the life sciences. General principles of biology and their relevance to society. 1005: Cell function and physiology, nutrition, circulation and water balance in plants and animals, hormones, nerves. 1006: Muscles, behavior, genetics, development, populations, evolution, ecology and the life kingdoms. (Duplicates 1105, 1106). (3H,3C)

1014: INTRODUCTION TO BIOLOGY
Introductory biology for non-life science majors. Topics covered include the hierarchy of living systems, cell structure, physiology, and reproduction, Mendelian genetics, molecular genetics, evolution, microbial diversity, plant anatomy and physiology, animal anatomy and physiology, and ecological systems. Ethical aspects of current research in these areas. Partially duplicates 1005, 1006, 1105, 1106. (3H,3C)

1015,1016: GENERAL BIOLOGY LAB
Primarily for students not majoring in the life sciences. Laboratory experiments emphasizing observation and experimental procedures to investigate biological processes and phenomena. 1015: Cell biology and genetics. 1016: Plant, animal and environmental biology. (Duplicates 1115, 1116; 1125, 1126). (2L,1C)

1024: CANCER: CAUSES, TREATMENTS, COSTS
Introduction to risk factors and biological mechanisms associated with cancer. Current approaches to cancer prevention, diagnosis, and treatment. Personal, socioeconomic, and global aspects of cancer. (3H,3C)

1034: BIOLOGY OF SEX
Sexual reproduction in living organisms from a scientific perspective including morphology, physiology, behavior, development and evolution. Biological basis and ethical considerations of human societal issues including contraception, homosexuality, and gender/sex. (3H,3C)

1054: HUMAN BIOLOGY: CONCEPTS AND CURRENT ISSUES
Survey of human biology, including physiology, genetics, evolution, and ecology. Focus on homeostasis, including factors and choices that disrupt homeostasis and health. Examination of technological advances and ethical issues associated with the biology of humans. Personal and societal choices that impact human ecology. (3H,3C)

1064: PLANTS AND CIVILIZATION
Survey of basic plant biology. Critical roles of plants as food, drugs, textiles, other products. Examination of the global, historical, and cultural links between plants and humans. Discussion of current topics, including biotechnology, global change, biodiversity loss, nutrition and drug addiction. (3H,3C)

1074: HOW ANIMALS THINK
Overview of scientific research on animal cognition and behavior from perspectives in biology, psychology, and neuroscience. Study and application of scientific approaches to the study of animal cognition and behavior in the context of personal, political, and societal decision making. Considers the influence of animal cognition and animal ethics on decisions about human-animal interactions at a personal and societal scale ranging from decisions about food supply to conservation. Provides the framework to evaluate animal personality, emotion, consciousness, and rights. Addresses how cultural,

social and political views influence scientific research on animal cognition. Consideration of bidirectional effects of human-animal interactions on One Health and animal welfare. (3H,3C)

1105,1106: PRINCIPLES OF BIOLOGY
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (Duplicates 1005, 1006). (3H,3C)

1115,1116: PRINCIPLES OF BIOLOGY LABORATORY
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences. (Duplicates 1015 1016, 1125, 1126). X-grade allowed. Co: 1105 for 1115; 1106 for 1116. (3L,1C)

1125,1126: BIOLOGICAL PRINCIPLES LAB
Emphasizes biological principles through experimental design and collaborative learning. 1125: cell chemistry, physiology and reproduction, genetics and evolution. 1126: plant and animal form and function, and ecology. This writing intensive course is part of the Writing Across the Major option; these two laboratory courses plus three additional designated Biology courses will fulfill the Area I Writing Intensive requirement for Biology majors. Primarily for students majoring in Biology. (Duplicates 1015, 1016, 1115, 1116). Co: 1106, 1105 for 1125. (3L,1C)

1135-1136: PHAGE HUNTERS
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases. (6L,2C)

1205H,1206H: HONORS BIOLOGY
Emphasizes biological principles through investigative exercises and collaborative learning. 1205H: cell chemistry and structure, energy transformations, genetics and microevolution. 1206H: macroevolution, plant and animal physiology, populations, ecology and behavior. This is a writing intensive course. Simultaneous enrollment in laboratory required. For students who qualify for the University Honors Program. (Duplicates 1005, 1006; 1105,1106). (3H,3L,4C)

1214: CAREERS IN MEDICINE
For students considering a career in health care. Investigation of various health care professions, including requirements for additional education and the professional and personal expectations characteristic of these professions. Introduction to biomedical ethics and health policy. Options for financing professional school. How to become a competitive applicant. (1H,1C)

1984: SPECIAL STUDY
Variable credit course.

2004: GENETICS
Mendelian transmission, chromosome behavior and organization, gene and chromosome mutation, genetic properties of nucleic acids, gene expression and development, DNA technology. X-grade allowed. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H), (CHEM 1036 or CHEM 1056 or CHEM 1036H or CHEM 1056H or CHEM 1016 or ISC 2105). (3H,3C)

2104: CELL AND MOLECULAR BIOLOGY
Fundamental molecular mechanisms essential for the function of prokaryotic and eukaryotic cells. Topics will include: organization and maintenance of cellular structure, energy production, transcriptional regulation, protein synthesis, regulatory pathways, cell-cell interactions and reproduction. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1106 or BIOL 1206H or BIOL 1006), (CHEM 1036 or CHEM 1056 or CHEM 1016 or CHEM 1036H or CHEM 1056H or ISC 2105). (3H,3C)

2124: CELL AND MOLECULAR BIOLOGY FOR ENGINEERS
Composition, structure and function of cells; fundamentals of gene expressions, cell physiology, cellular movement and reproduction; stem cells and tissue formation; synthetic biology and applied cell and molecular biology. Not for Biological Sciences majors. Pre: ENGR 2164 or COS 2164. (2H,2C)

2134: CELL FUNCTION AND DIFFERENTIATION
Fundamental mechanisms essential for cell function. Methods used to study cells. Cellular structure and physiology, energy production, cell survival and reproduction. Cell interactions and communication, stem cells, cell differentiation, tissue formation. Pre: 2004. (3H,3C)

2304 (HORT 2304): PLANT BIOLOGY
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

2404 (ALS 2404): BIOTECHNOLOGY IN A GLOBAL SOCIETY
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening. Pre: (1005, 1006) or (1105, 1106) or (1205H, 1206H), CHEM 1015, CHEM 1016. (3H,3C)

2504: GENERAL ZOOLOGY
Morphology, features, adaptations, and ecology of major animal groups, emphasizing major patterns of evolutionary change. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

2604: GENERAL MICROBIOLOGY
Microbial structure, function, metabolism, genetics and ecology. The role of microorganisms in host/parasite relationships will be emphasized. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H), (CH EM 1036 or CHEM 1056 or CHEM 1036H or CHEM 1056H or ISC 2105). (3H,3C)

2604H: HONORS GENERAL MICROBIOLOGY
Microbial structure, function, metabolism, genetics and ecology. The role of microorganisms in host/parasite relationships will be emphasized. Additional written assignments, class discussions, and readings from the primary literature will be required. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H), (CH EM 1036 or CHEM 1056 or CHEM 1036H or CHEM 1056H or ISC 2105). (3H,3C)

2614: GENERAL MICROBIOLOGY LABORATORY
Introduction to microbiological techniques and procedures. Aseptic technique and safe handling. Culture, characterization, and identification of microorganisms. Pre: (1005 or 1105 or ISC 2105), (BIOL 1006 or BIOL 1106), (CHEM 1036 or CHEM 1056 or CHEM 1036H or CHEM 1056H or ISC 2105). Co: 2604. (4L,2C)

2704: EVOLUTIONARY BIOLOGY
Evolutionary mechanisms, systematic principles, and theories of the origin and evolution of life. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

2704H: EVOLUTIONARY BIOLOGY
Evolutionary mechanisms, systematic principles, and theories of the origin and evolution of life. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

2804: ECOLOGY
Fundamental interaction of organisms with the biotic and abiotic components of ecosystems. Topics will include: physical environment and organismic interactions, concepts of population ecology and community ecology, ecosystems interactions, and environmental problems. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

2804H: HONORS ECOLOGY
Fundamental interaction of organisms with the biotic and abiotic components of ecosystems. Topics will include: physical environment and organismic interactions, concepts of population ecology and community ecology, ecosystems interactions, and environmental problems. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

29844: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

2994H: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

3014 (ENT 3014): INSECT BIOLOGY
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional. Pre: (1005, 1006) or (1105, 1106) or (1205H, 1206H). (2H,2C)

3024 (ENT 3024): INSECT BIOLOGY LABORATORY
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required. Pre: (1005, 1006) or (1105, 1106) or (1205H, 1206H). Co: 3014. (1H,3L,2C)

3104: CELL AND MOLECULAR BIOLOGY LABORATORY
Introduction to methods used to study prokaryotic and eukaryotic cells. Recombinant DNA, protein expression and purification, the polymerase chain reaction, bioinformatics, and microscopy. Pre: 2104 or 2134. (3L,1C)

3114: FIELD AND LABORATORY ECOLOGY
Experimental and field studies of population growth, competition, stressed ecosystems, plant distribution, and other interactions of plants, animals and microbes with their environments. Several required weekend field trips. Pre: 2804 or 2804H. (3L,1C)

3134: HUMAN GENETICS
Principles of genetic analysis in humans with emphasis on genetic diseases of humans; methods of karyotyping human chromosomes; methods of pedigree and genetic analysis of humans; principles, techniques, and analysis of twin studies in humans; techniques used to identify and characterize normal and abnormal chromosomes; principles and methods of DNA fingerprint analysis of humans. Pre: 2004 or 2104 or 2134. (3H,3C)

3204: PLANT TAXONOMY
Systematic survey of vascular plants, emphasizing identification, terminology, classification, evolutionary relationships. X-grade allowed. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or

BIOL 1206H). (2H,3L,3C)

3254 (ENT 3254): MEDICAL AND VETERINARY ENTOMOLOGY
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed Pre: (1005, 1006) or (1105, 1105) or (1205H, 1206H). (3H,3C)

3264 (ENT 3264): MEDICAL AND VETERINARY ENTOMOLOGY LABORATORY
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group. Pre: (1105, 1106) or (1005, 1006) or (1205H, 1206H). Co: 3254. (3L,1C)

3404: INTRODUCTORY ANIMAL PHYSIOLOGY
A comparative systems level approach to the physiology of animals, emphasizing vertebrates: metabolic, temperature, osmotic, and ionic regulation; function of respiratory, circulatory, digestive, muscle, nervous, and locomotory systems; endocrine regulation and biological rhythms. Must have prerequisites or instructor's permission. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

3454: INTRODUCTORY PARASITOLOGY
Ecology, taxonomy, morphology, life cycles, pathogenesis, and host-parasite relationships of parasitic eukaryotes. Pre: (1005 or 1105 or 1205H or ISC 2105), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3L,4C)

3504: HEALTH PROFESSIONS PRECEPTORSHIP
Cooperative shadowing experience in conjunction with select regional hospitals and local health provider. Students observe various medical or dental specialties under the supervision of health professionals. Selection by Director, Office of Health Professionals Advising, and prehealth advisors. Approval by health faculty and mentor required. Pre: junior standing; minimum overall GPA of 3.3. Pass/Fail only. Pre: 1105, 1106, CHEM 1036. (6L,2C)

3514: INTRODUCTION TO HISTOLOGY
Overview of tissue structure and function in the human body; microscopic examination of tissue sections; organization of tissues in different organ systems; histopathology of tissues and organs. Pre: 2104 or 2134. (2H,3L,3C)

3604 (FST 3604): FOOD MICROBIOLOGY
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Methods to enumerate, identify, and characterize microorganisms in foods. Pre: 2604, 2614. (3H,3L,4C)

3764: CAREERS IN MICROBIOLOGY
Contemporary research topics in microbiology, methods of research data analysis, the research publication process, research presentation and interview skills, career paths for microbiology graduates, preparation for graduate school, preparation for entry into the job market. Pre: 2604. (3H,3C)

3774: MOLECULAR BIOLOGY
Advanced study of the molecular biology of prokaryotic and eukaryotic cells, including mechanisms of gene expression and regulation, relative merits of experimental model systems, and practical applications in agriculture and medicine. Pre: 2104 or 2134 or ALS 3104. (3H,3C)

3804: PRINCIPLES OF BIOLOGY TEACHING ASSISTANT
For undergraduate teaching assistants (UTAs) facilitating BIOL 1105 or 1106 class sections that utilize active-learning pedagogies and require facilitation of in-class learning activities. Content and practice of teaching strategies and professionalism in the classroom. Supervision by departmental faculty or staff. Selection by Principles of Biology instructional team. May be repeated four times with different content for

a maximum of eight credits. Junior Standing, overall minimum GPA of 3.0. Pre: 1105, 1106. (6L,2C)

3814: CAREERS IN BIOLOGICAL SCIENCES
Exploration of career opportunities in the biological sciences, including employment and further education. Professional development activities, including resumes, career fairs, networking, preparation for interviews, ethics, and assessment and comparison of job offers. Does not count for Biological Sciences or Microbiology elective credit. Pre: junior standing (1H,1C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4004: FRESHWATER ECOLOGY
Interactions of physical, chemical, and biological properties of freshwater ecosystems. Pre: 2804 or 2804H. (3H,3L,4C)

4014: ENVIRONMENTAL TOXICOLOGY
Discussion of ecotoxicological and philosophical issues in the development of standards for control of toxic chemicals in freshwater, including site-specific examples, application of current control methods, recovery of damaged ecosystems, and government regulations. Pre: 2804. (2H,2C)

4104: DEVELOPMENTAL BIOLOGY
Morphological, physiological, and molecular events in embryological and developmental systems, including regulation at the level of transcription, translation, and enzyme or hormone activation. Pre: 2004. (3H,3C)

4114: GLOBAL CHANGE ECOLOGY
Effects of human alteration of climate, landscapes and biogeochemical cycling on ecological structure and functioning at the global scale. Influence of global changes on ecosystem processes and biodiversity with paleo- and contemporary examples. Current and future potential feedbacks between biological systems and the global environment. Pre: (2704 or 2704H), 2804. (3H,3C)

4134: EVOLUTIONARY GENETICS
Genetic variation, Hardy-Weinberg equilibrium, agents of change in gene frequencies, molecular evolution, mechanisms of speciation. Comparison of theoretical models with natural and laboratory populations. Pre: 2004, (2704 or 2704H). (3H,3C)

4164 (CSES 4164) (ENSC 4164): ENVIRONMENTAL MICROBIOLOGY
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling. Pre: 2604. (2H,3L,3C)

4314: PLANT ECOLOGY
Introduction to ecology of terrestrial plants including major plant functional types, ecophysiological aspects of functional types, molecular plant ecology, behavior of populations, responses of plant communities to disturbance, and vegetation analysis. Laboratory covers methods for measuring and analyzing natural vegetation, and setting up field and greenhouse experiments. Pre: (2304 or 2804 or FOR 3314) or HORT 2304. (3H,3L,4C)

4334: CHEMICAL ECOLOGY
Chemical interactions between organisms with emphasis on the plant biosphere. Fundamental concepts, theories, and general methodology of chemical ecology: mechanisms of chemically- mediated interactions; and engineering of natural chemical defenses in sustainable agriculture. Pre: (2304 or 2804 or FOR 2314 or BCHM 4115), CHEM 1035. (3H,3C)

4354 (ENT 4354): AQUATIC ENTOMOLOGY
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organisms in aquatic ecology, pollution monitoring, and natural resource management. Pre: (1005, 1006), (1015, 1016) or (1105, 1106, 1115, 1116). (3H,3L,4C)

4404: ORNITHOLOGY
Biology of birds, including functional anatomy, systematics, evolutionary history, behavior, and ecology. Laboratory on systematics, anatomy, and field experience in the areas of behavior and ecology. Pre: 2804. (3H,3L,4C)

4454: INVERTEBRATE ZOOLOGY
Identification, morphology, evolutionary relationships, and natural history of free-living invertebrates, excluding insects. Pre: 2504. (3H,3L,4C)

4474: ETHOLOGY
An evolutionary and ecological approach to animal behavior, drawing on behavioral genetics, endocrinology, neurophysiology, and behavioral ecology to explain how and why the behavior of an organism is adapted to its environment. Pre: 2504. (3H,3C)

4484 (ENT 4484) (FIW 4484): FRESHWATER BIOMONITORING
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results. Pre: (2804), (4004 or 4354 or ENT 4354 or FIW 4424 or FIW 4614). (3H,3L,4C)

4554 (ALS 4554): NEUROCHEMICAL REGULATION
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet. Pre: (ALS 2304 or BIOL 3404), (CHEM 2535). (3H,3C)

4564: INFECTIOUS DISEASE ECOLOGY
Principles of infectious disease dynamics from ecological and evolutionary perspectives. Examines a variety of wildlife hosts and disease-causing agents (bacteria, viruses, and parasites) using the framework of agent-host- environment interactions. Selective coverage of specific host and pathogen models to illustrate underlying principles of wildlife disease emergence, maintenance, and spread, as well as connections between wildlife and human health. Pre: (2704 or 2704H), (2804 or 2804H). (3H,3C)

4574 (ALS 4574): SOCIAL BEHAVIOR OF BIRDS AND MAMMALS
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural companion and laboratory settings are discussed. Pre: 1106, ALS 3104 or BIOL 2004. (3H,3C)

4594: ECOLOGY, EVOLUTION, AND BEHAVIOR SENIOR SEMINAR
Review and discussion of contemporary research topics in ecology, evolution, and behavior, the research process, methods for communicating science to professional and non-professional audiences, professional development for careers in ecology, evolution and behavior. Pre: 2704, 2804. (3H,3C)

4624: MICROBIAL GENETICS
Molecular genetics of bacteria and their associated plasmids and phages. Pre: 2004, (2604 or 2604H). (3H,3C)

4634: MICROBIAL PHYSIOLOGY

The study of the structure, function and metabolic activities of prokaryotic microorganisms. Topics covered included cell composition and growth, metabolic unity and diversity, patterns of regulation, transport mechanisms, environmental sensing and response and cellular differentiation processes. (BIOL 4624 is recommended, but not required.) Pre: (2604 or 2604H), (2104 or 2004 or 2134). (3H,3C)

4644: MICROBIAL MOLECULAR GENETICS AND PHYSIOLOGY LABORATORY
Introduction to classical and molecular methods used for the study of bacterial genetics and physiology. Laboratory exercises cover analysis of patterns of gene regulation; assay of enzymatic activities; mutagenesis followed by selection, screening, and physiological characterization of mutant strains; genome database utilization; and large scale fermentation. Pre: (2004 or 2104) or 2134, (2604 or 2604H), 2614. (1H,6L,3C)

4664: VIROLOGY
Classification, structure, pathogenesis, host response, and replication strategies of viruses of bacteria, plants, and animals, stressing mechanisms elucidated by molecular biological techniques. Pre: 2104 or 2134, (2604 or 2604H), 2614. (3H,3C)

4674: PATHOGENIC BACTERIOLOGY
Characteristics of bacteria that cause human disease, nature of infectious processes, virulence factors, epidemiology, resistance, immunization. Pre: 2004, 2104 or 2134, (2604 or 2604H), 2614. (3H,3C)

4704: IMMUNOLOGY
Immunochemistry of antigens and antibodies, serological reactions, chemistry of complement, control of immunity, immune response of an intact animal. Pre: 2104 or 2134. (3H,3C)

4714: IMMUNOLOGY LABORATORY
Serological and immunobiological techniques used to interpret the consequences of an immune response. Pre: 2104 or 2134. Co: 4704. (3L,1C)

4724: PATHOGENIC BACTERIOLOGY LAB
Microbiological techniques used to identify and characterize bacteria that cause infectious disease. Pre: 2004, 2104 or 2134, (2604 or 2604H), 2614. Co: 4674. (4L,2C)

4734: INFLAMMATION BIOLOGY
Cellular and molecular pathways controlling human responses to inflammatory challenges. Regulation of immune cells during inflammation. Interaction of host cells and tissues with environmental risk factors that cause inflammation. Pathogenesis of inflammatory diseases including cardiovascular diseases, diabetes, multi-organ failure, aging, neurological diseases and sepsis. Therapeutic intervention of inflammatory diseases. Pre: 2104 or 2134. (3H,3C)

4774: MOLECULAR BIOLOGY LAB
An introduction to recombinant DNA methods, including restriction endonuclease digestion, gel electrophoresis, cloning, Southern blotting, polymerase chain reaction, sequencing and analysis of reporter gene expression in transgenic organisms. BIOL 3774 may be taken as a corequisite with 4774. Pre: 3774. (1H,6L,3C)

4804: PROKARYOTIC DIVERSITY
The study of the vast array of physiological, morphological, and behavioral properties of prokaryotes. Topics include: modern prokaryotic classification, prokaryotic diversity, relationship and importance to cell and molecular biology and biochemistry, application and use in industry and agriculture, and to the maintenance of the biosphere. Must have pre-requisites or consent of the instructor. Pre: (2604 or 2604H), 2614, (3124 or 4634 or BCHM 3114). (3H,3C)

4824: BIOINFORMATICS METHODS
Application of bioinformatics methods in biological research. Methods to access bioinformatics data. Theory and methods for analysis of DNA sequences, and analysis of complex data sets including whole genome sequences and gene expression data. Use of standard bioinformatics software and databases. Pre: 2004, (2104 or 2134). (2H,3L,3C)

4834: PRACTICAL ANALYSIS OF PROTEIN STRUCTURE AND FUNCTION
Application of biophysical and biomechanical methods to characterization of protein structure and function, macromolecular interactions and conformational changes. Strategies, experimental design, practical considerations, troubleshooting, data analysis. Pre: (2104 or 2134), (CHEM 2536 or CHEM 2566), (PHYS 2206 or PHYS 2306). (2H,3L,3C)

4844: PROTEOMICS AND BIOLOGICAL MASS SPECTROMETRY
Introduction to mass spectrometry (MS) instrumentation and advanced proteomic methods for systems biology applications. Peptide mass fingerprinting, tandem MS, quantitation, phospho/glyco proteomics, and bioinformatics tools for evaluation and interpretation of mass spectrometry data. Pre: 2104 or 2134, CHEM 2536, PHYS 2205, PHYS 2206. (3H,3C)

4854: CYTOGENETICS
Structure and function of eukaryotic chromosomes, with emphasis on (i) use of model systems to study specific chromosome substructures or functions; (ii) techniques used to identify and classify both normal and aberrant chromosomes; and (iii) diseases caused by defective chromosome structure and/or function. Pre: 2004, 2104 or 2134. (3H,3C)

4874: CANCER BIOLOGY
The molecular and cellular basis of cancer, including viral and cellular oncogenes, tumor suppression mechanics, cellular immortality, genomic integrity, angiogenesis, metastasis, and traditional and developing theories. Pre: 2004, (2104 or 2134). (3H,3C)

4884: CELL BIOLOGY
Advanced study of the inner workings of eukaryotic cells, including membrane structure and function, protein secretion, the cytoskeleton, cell cycle control and intercellular communication. Pre: 3774 or BCHM 4116. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Business Information Technology

Head: R. S. Russell
Andersen Professor of Management Science: L. P. Rees
Bank of America Professor: C.T. Ragsdale
R. B. Pamplin Professors of Management Science: B. W. Taylor III and C. W. Zobel
Houchens Professor of Management Science: T. R. Rakes
Ralph Medinger Lenz Professor in Business: R. D. Badinelli
Richard E. Sorensen Dean's Chair: R. T. Sumichrast
Suzanne Parker Thornhill Professor of Business Information Technology: P.B. Lowry
Professors: P. Ghandforoush, L.Z. Khansa, R.S. Russell
Associate Professors: A. S. Abrahams, I. Adjerid, J.K. Deane, B. J. Hoopes, T. L. James, R. L. Major, L. A. Matheson, Q. J. Nottingham, O. Seref, and G. Wang
Assistant Professors: V. Mindel and W. Shen
Collegiate Professor: D.G. Simpson
Collegiate Associate Professor: W.H. Baker, M.M.H. Seref, J. M. Teets
Assistant Professors of Practice: B. Fraticelli, J. Kern, J. Monday, D. Simundza, and L. Travis
Advanced Instructor: L.L. Clark
Career Advisor: R. S. Russell (540-231-6596)

Web: **www.bit.vt.edu/**

Overview

The Department of Business Information Technology offers an undergraduate major in business information technology with options in computer-based decision support systems, operations and supply chain management, and cybersecurity management and analytics. The department also offers and staffs business courses such as business analytics and modeling, systems analysis and database management, and data governance, privacy and ethics. Specific Business Information Technology (BIT) courses are listed below.

The department participates in the Cooperative Education Program in which qualified students may alternate semesters of study with semesters of professional employment.

Business Information Technology

The curriculum in business information technology is designed to provide the student with expertise in the quantitative and technological aspects of management, specifically including the extensive use of computers for solving business problems and making managerial decisions. The name business information technology implies the application of scientific principles and techniques, mathematics, and computing to the management function with the objective of increased efficiency and productivity. Thus, the student of business information technology not only learns various quantitative techniques and models to apply to managerial problems, but also a logical and scientific approach to managerial decision-making. The curriculum provides training both for individuals interested in pursuing careers in business management and for individuals interested in pursuing graduate or professional degrees. Students majoring in business information technology may choose one of two options reflecting their particular career objectives and interests.

Option I - Computer-Based Decision Support Systems (BIT-DSS)

This option educates the student in the design, implementation, and use of computerized information systems, decision support systems, AI and expert systems which support contemporary business managers in the decision-making process. Special emphasis is placed on increased productivity and effectiveness through the use of models, quantitative data, and analytics embedded within a computerized decision support system. Training in Option I will enable graduates of this program to pursue careers in business and industry in which data analytics and computer-aided decision-making is an essential component of the managerial function.

Option II - Operations and Supply Chain Management (BIT-OSM)

This option educates students in the management of activities directly related to the creation and distribution of

goods and services. The curriculum of Option II is designed to provide the student with expertise in the planning and control of business processes within a firm and across its global supply chain. Emphasis is placed on applying IT, analytics and process analysis skills to improve the quality and productivity of business firms and their supply chain partners. Graduates of this program will be prepared to pursue careers as operations managers, business process managers, project managers, supply chain analysts, and quality, logistics, inventory or procurement managers in business, industry, and government.

Option III - Cybersecurity Management and Analytics (BIT-Cyber)

This option emphasizes business processes and data analytics as applied to cybersecurity management. BIT-Cyber students will gain proficiency in the business management of cybersecurity within an organization, including knowledge management, setting policies, risk management, incident business response, using data to understand attacks on business assets, and overall management of the cybersecurity function within a business. Graduates of the program will be prepared for jobs as analysts, auditors, managers and planners within the cybersecurity function.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (BIT)

2164 (CS 2164) (PSCI 2164): FOUNDATIONS OF CONTEMPORARY SECURITY ENVIRONMENTS
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats. (3H,3C)

2404 (MGT 2404): MULTICULTURAL PROBLEM SOLVING AND ANALYTICS
Study of how people and organizations in multiple cultures analyze, model and solve problems from a business perspective. Addresses ethical considerations in developing and solving problems. No statistics background is required. Sophomore standing. Pre: MATH 1025, (MATH 1225 or MATH 1525). (3H,3C)

2405,2406: INTRODUCTION TO BUSINESS STATISTICS, ANALYTICS, & MODELING
Introduction to basic statistical (inference) tools, analytics techniques, and modeling necessary in managerial decision-making. The decision-making aspect of the course, while utilizing quantitative/computational thinking, will emphasize ethical reasoning. Topics include, but are not limited to, descriptive statistics, elementary probability theory, sampling and sampling distributions, portfolio management, hypothesis testing, regression analysis, analysis of variance, big data, and data analytics. Pre: MATH 1524 or (MATH 1525, MATH 1526) or (MATH 1205, MATH 1526) or (MATH 1225, MAT H 1526) or (MATH 1016, MATH 1526) or (MATH 1525, MATH 2015, MATH 1114) or (MATH 1016, MATH 2015, MATH 1114) or (MATH 1015, MATH 1525, MATH 2015) or (MATH 1015, MATH 1525, MATH 1206) or (MATH 1015, MATH 1205, MATH 2015) or (MATH 1525, MATH 1206, MATH 1114) or (MATH 1016, MATH 1206, MATH 1114) or (MATH 1205, MATH 1526) or (MATH 1225, MATH 1 526) or (MATH 1016, MATH 1526) or (MATH 1025, MATH 1526) or (MATH 1205, MATH

1206, MA TH 1114) or (MATH 1205, MATH 1206, MATH 2114) or (MATH 1225, MATH 1226, MATH 1114) or (MATH 1225, MATH 1226, MATH 2114) or (MATH 1525, MATH 1206, MATH 1114) or (MATH 1525 , MATH 1206, MATH 2114) or (MATH 1525, MATH 1226, MATH 1114) or (MATH 1525, MATH 1226 , MATH 2114) or (MATH 1016, MATH 1206, MATH 1114) or (MATH 1016, MATH 1206, MATH 2114) or (MATH 1016, MATH 1226, MATH 1114) or (MATH 1016, MATH 1226, MATH 2114) or (MATH 1025, MATH 1206, MATH 1114) or (MATH 1025, MATH 1206, MATH 2114) or (MATH 1025, MATH 1226, MATH 1114) or (MATH 1025, MATH 1226, MATH 2114) for 2405; 2405 or STAT 3005, MA TH 1524 or MATH 1525, MATH 1526 or (MATH 1205, MATH 1526) or (MATH 1225, MATH 1526) o r (MATH 1016, MATH 1526) or (MATH 1025, MATH 1526) or (MATH 1205, MATH 1206, MATH 111 4) or (MATH 1205, MATH 1206, MATH 2114) or (MATH 1225, MATH 1226, MATH 1114) or (MATH 1225, MATH 1226, MATH 2114) or (MATH 1525, MATH 1206, MATH 1114) or (MATH 1525, MATH 1206, MATH 2114) or (MATH 1525, MATH 1226, MATH 1114) or (MATH 1525, MATH 1226, MATH 2114) or (MATH 1016, MATH 1206, MATH 1114) or (MATH 1016, MATH 1206, MATH 2114) or (MATH 1016, MATH 1226, MATH 1114) or (MATH 1016, MATH 1226, MATH 2114) or (MATH 1025, MATH 1206, MATH 1114) or (MATH 1025, MATH 1206, MATH 2114) or (MATH 1025, MATH 1226, MATH 1114) or (MATH 1025, MATH 1226, MATH 2114) for 2406. (3H,3C)

2954: BUSINESS STUDY ABROAD
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to develop information technology or operations management related free electives. Pre: Instructor’s consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent. Variable credit course.

3414: OPERATIONS AND SUPPLY CHAIN MANAGEMENT
Study of the process directly related to the creation and distribution of goods and services. Increasingly, these operations are taking place outside the boundaries of a traditional enterprise. This course teaches students how to analyze processes, ensure quality, create value, and manage the flow of information, products and services across a network of customers, enterprises and supply chain partners. Pre: 2406, ACIS 2116, ECON 2006. (3H,3C)

3424: INTRODUCTION TO BUSINESS ANALYTICS MODELING
Introduction of modeling of problems encountered in business analytics. Statistical and optimization modeling, computer solution, and analysis of business problems. Uses spreadsheet and database software to facilitate the modeling and solution of these problems. Pre: 2406. (3H,3C)

3434: ADVANCED MODELING FOR BUSINESS ANALYTICS
Study of selected, advanced topics in decision modeling and business analytics. Emphasis on model formulation, solution techniques, interpretation of results and comprehensive approaches to problem-solving. Integer, multi-criteria, and non-linear programming as well as network analysis and heuristics. Includes case studies and use of Excel as the primary analytical tool. Pre: 2406. (3H,3C)

3444: ADVANCED BUSINESS COMPUTING AND APPLICATIONS
Study of selected advanced topics in business computing. Construction of business applications using an advanced application development environment such as Visual Studio.net. Coverage of computer terminology, HTML, and Internet applications. The course builds computer literacy and strong programming skills. Junior standing required. Pre: 3424, (CS 1054 or CS 1064 or CS 1114). (3H,3C)

3454: BUSINESS PROCESS IMPROVEMENT
Examines the technical aspects of business process improvement focusing on improvement strategies, quality control, data analysis and mining, and maturity models. Emphasizes analytical techniques for business process design, control, and improvement. Pre: 3414. (3H,3C)

3464: ENTERPRISE PLANNING AND CONTROL SYSTEMS
The study of the design, analysis and implementation of enterprise-wide resource planning and control systems. The course examines decision support models for production planning, master scheduling, inventory control, shop floor control and related topics in planning and control. The course emphasizes the application of information technologies such as ERP, MRPII, CIM to operations planning and control. Pre: 3414. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4164 (CS 4164) (PSCI 4164): FUTURE OF SECURITY: INTEGRATIVE SOLUTIONS FOR COMPLEX SECURITY SYSTEMS Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events. Pre: PSCI 2164 or BIT 2164 or CS 2164. (3H,3C)

4424: BUSINESS INFORMATION VISUALIZATION AND ANALYTICS
Basic perception and design principles and techniques for information visualization, with an emphasis on the application of visualization software for data exploration and the development of analytical skills for business. Includes hands-on exposure to information visualization and statistical software. Pre: 2406. (3H,3C)

4434: COMPUTER SIMULATION IN BUSINESS
In-depth study of the application of computer simulation techniques to business decision making and process improvement. The theory of computer simulation and statistical analysis of results are included. Attention is focused on using simulation software stressing application to specific problems. Pre: 3414. (3H,3C)

4444: WEB-BASED DECISION SUPPORT SYSTEMS
Study of current technologies for designing and constructing interactive, Internet-based systems for supporting business decisions. Topics may include the operation of the Internet, server-side programming, client-side programming, server-side scripting, XML, XHTML, database integration, COM, CGI, and others. Design issues will be explored through a class project. Pre: 3444. (3H,3C)

4454: BUSINESS ANALYSIS SEMINAR IN IT
Comprehensive treatment of Decision Support Systems (DSS) as managerial tools, particularly in an e-commerce environment. Emphasis is at the builder and user level. A primary emphasis is on problem solving through the integration of various quantitative techniques as well as on IT concepts. The course includes a comprehensive project using state-of-the-art software. Pre: 3434, 4444, 4514. (3H,3C)

4464: ADVANCED SUPPLY CHAIN MANAGEMENT
Advanced study of efficient methods for streamlining the production and delivery of products and services across functions, enterprises and global boundaries. Topics include the facilities, functions, technologies, and activities involved in creating and delivering products and services, especially in a digital marketplace. Designing and managing a network of suppliers across enterprises is discussed, along with the information systems, risk management and planning issues involved. Pre: 3414. (3H,3C)

4474: GLOBAL OPERATIONS AND INFORMATION TECHNOLOGY
This course includes concepts and issues critical in the globalization of business operations and information technology. Topics covered include the organization of global operations, cultural and national comparisons, planning global operations, facilities location, product development, technology transfer, global communication links, transborder data flow, international information systems, and other emerging operations and information technology issues. Pre: 3414. (3H,3C)

4484: PROJECT MANAGEMENT
Study of efficient methods for planning and controlling projects. Topics include project management and scheduling tools, project quality assurance, risk and cost control, resource constrained scheduling, definition and requirements analysis, task integration, and managing alliances. The application of information technology to project management and control is emphasized throughout the course. Pre: 3414. (3H,3C)

4514: DATABASE TECHNOLOGY FOR BUSINESS
Study of the design of databases and data structures for supporting business. Topics include basic database structure and design, structured query language, database management systems, integration of backend database servers, data warehousing and mining, on-line analytical processing, and database application, security, and management. Pre: 3424, 4524. (3H,3C)

4524: SYSTEMS DEVELOPMENT
Study of the current technologies for designing and developing computer-based business systems. Topics will include process, logic, and conceptual data modeling methodologies such as Uniform Modeling Language (UML) and important design-related issues such as data flows and system capabilities. Design issues will be explored through class projects. Pre: 2406. (3H,3C)

4544: ADVANCED METHODS IN BUSINESS ANALYTICS
Study of key methods in business analytics and their role in decision making in the business context. Emphasizes data systems and methods for extracting knowledge from these systems. Business intelligence, data mining and data classification, text mining and web mining, data warehousing, geographic information systems, artificial intelligence, heuristics, and semantics and ontologies. Pre: 3444 or ACIS 2504. (3H,3C)

4554 (ACIS 4554): NETWORKS AND TELECOMMUNICATIONS IN BUSINESS
This course provides an in-depth introduction to computer networks and data communications in business. Topics include mechanisms for reliable data transfer, local and wide area network topologies and technologies, and a comprehensive treatment of internetworking. The benefits, costs, and security issues related to using computer networks are discussed, along with network design issues, and methodologies for network applications. One semester of college-level programming experience required. Pre: 3424 or ACIS 3504. (3H,3C)

4604: DATA GOVERNANCE, PRIVACY AND ETHICS
Examination of data analytics and automated decision making issues, across multiple technology contexts, through the lens of the humanities and ethics. Privacy, autonomy, data ownership, equality, and accountability. Decision making and exploration of questions of data ethics and data fairness throughout the data life cycle. Pre: 2405 or CMDA 2014 or CS 1114 or CS 1054 or CS 1064. (3H,3C)

4614: INFORMATION SECURITY
Study of policies, procedures, and technologies for enhancing the security of information. Topics include physical security, communications security, emissions security, computer security, and network security. The core security goals of confidentiality, integrity, and availability are emphasized throughout the course. Pre: 3424. (3H,3C)

4624: CYBERSECURITY ANALYTICS FOR BUSINESS
Application of advanced analytics to cybersecurity in a business setting. Categorization of cyber threats and solutions. Data mining, visualization and machine learning applied to large data sets for anomaly detection, threat prediction, and incident response analysis. Investigation of adversarial machine learning. Selection of appropriate analytics techniques and security platforms. Consideration of business and ethical issues. Pre: 4614. (3H,3C)

4854 (MGT 4854): ANALYTICS IN ACTION
Problem-solving framework and analytic techniques for solving messy, unstructured, high-impact, real-world organizational/societal problems within an interdisciplinary, intercultural, experiential learning context. Definition of problem scope, objectives, need for change, ethical concerns, and diversity and inclusion issues; identification of stakeholders and their values; evaluation of decision tradeoffs; problem decomposition and hypothesis formulation; project planning and administration; data versus user requirements, ethical and inclusive decision making, data collection, preparation, and analysis; team roles and management; professional communication of insights, policy and action recommendations. Pre: CMDA 2014, BDS 2005. (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY

Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Biological Systems Engineering

Interim Head: R. D. Grisso
Professors: J. R. Barone, B. L. Benham, R. D. Grisso, W. C. Hession, S. Mostaghimi, M. L. Wolfe, and C. Zhang
Associate Professors: J. Arogo Ogejo, Z. M. Easton, L.-A. H. Krometis, D.J. Sample, D. Scott, R.S. Senger, V. R. Sridhar, and T. M. Thompson
Assistant Professors: R. C. Wright, J.A. Czuba, and J. E. Shortridge
Instructor: S. C. Mariger

Web: **www.bse.vt.edu**

Overview

The mission of the Department of Biological Systems Engineering (BSE) is to develop and disseminate engineering knowledge and practices that protect natural resources and improve sustainable production, processing, and utilization of biological materials.

The teaching program in BSE offers engineering B.S., M.S., and Ph.D. programs for students enrolled in the College of Engineering and service courses for students enrolled in the College of Agriculture and Life Sciences and other colleges. The degree programs in BSE are administered by the College of Engineering; therefore, the curriculum and courses offered for the B.S. in biological systems engineering are listed in the College of Engineering section of this catalog. Students interested in pursuing an undergraduate degree program in Biological Systems Engineering must first be admitted to the College of Engineering.

Service courses designed to meet the needs of students enrolled in different programs in CALS are listed

in the following section. These courses generally are not taken to meet engineering degree requirements except as free electives.

Undergraduate Course Descriptions (BSE)

2004: INTRODUCTION TO BIOLOGICAL SYSTEMS ENGINEERING
Introduction to the fundamental concepts of Biological Systems Engineering, including statistics, heat and mass balances, protein separation, microbial metabolism, and enzyme kinetics. Engineering design process, engineering problem-solving tools and techniques, development of oral and written communication skills, and the importance of teamwork and ethics in Biological Systems Engineering. Pre: ENGE 1024 or ENGE 1215 or ENGE 1414. (1H,3L,2C)

2094: INTRODUCTION TO METAL FABRICATION
Introduction to metal working tools, equipment, and processes. Fundamentals of gas and arc welding. (3L,1C)

2294: ANIMAL STRUCTURES AND ENVIRONMENT
Functional considerations in facilities development for production agriculture. Concepts of farmstead planning and system development emphasized. Techniques for providing production animal environment, especially for confinement facilities. Pre: (MATH 1016 or MATH 1025). (3H,3C)

2304: LANDSCAPE MEASUREMENTS AND MODELING
Introduction to land surveying, computer-aided design, and drafting for land and water resources engineering. Representation of features in two and three dimensions for documentation and visualization of watershed engineering projects. Create plans, cross sections, detail drawings, and three dimensional visualizations using computer-aided design and drafting tools. Pre: (MATH 1206 or MATH 1226). (2H,3L,3C)

2484: ENGINE AND POWER TRAIN TECHNOLOGY
Fundamentals of the construction and operation of current internal combustion power units. Control of power utilizing clutches, transmissions, drive shafts, and differentials. Pre: (MATH 1016 or MATH 1025). (2H,3L,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3134: BIOLOGICAL SYSTEMS ENGINEERING SEMINAR
Critical review of technical and professional articles on current topics in Biological Systems Engineering. Development of oral presentation and technical writing skills. Contemporary ethical, professional, and global issues in Biological Systems Engineering. Pre: 2004. (2L,1C)

3144: ENGINEERING ANALYSIS FOR BIOLOGICAL SYSTEMS USING NUMERICAL METHODS
Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation and numerical solution of ordinary differential equations. Error analysis and programming with engineering software. Course requirements may be satisfied by taking MATH 2214 prior to or concurrent with course. Co: MATH 2214. (2H,2C)

3154: THERMODYNAMICS OF BIOLOGICAL SYSTEMS
Fundamental concepts, first and second laws, psychrometrics applied to plant and animal environments, introduction to Gibbs energy, and application of calorimetry to gain basic understanding of energy flow in a biological system. Course requirements may be satisfied by taking CEE 3304 or CHE 3114 or ESM 3234 or ESM 3024 or ME 3404 prior to or concurrent with course. Pre: ESM 2304, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

3324: SMALL WATERSHED HYDROLOGY

Precipitation, soil physics, infiltration, evapotranspiration, groundwater hydrology, overland flow, open channel flow, flow routing, hydraulic analysis. Course requirements may be satisfied by taking CEE 3304 or CHE 3114 or ESM 3234 or ESM 3024 or ME 3404 prior to or concurrent with course. (3H,3C)

3334: NONPOINT SOURCE POLLUTION ASSESSMENT AND CONTROL
Erosion prediction and control; transport and fate of sediment, nutrients, and microorganisms; design of nutrient management plans, wetlands, detention facilities and other management practices for rural and urban nonpoint source pollution control. Pre: 3324. (2H,3L,3C)

3494: ADVANCED WELDING TECHNOLOGY
Techniques in welding that include gas, submerged metal arc, metal inert gas, pulsed arc, and tungsten inert gas welding. Design of welding structures, fundamentals of heat treatment, and plasma arc cutting. Consent required. (3L,1C)

3504: TRANSPORT PROCESSES IN BIOLOGICAL SYSTEMS
Introduction to material and energy balances in biological systems. Fundamentals of heat and mass transfer in biological systems. One and two dimensional conduction, convection, and diffusion of thermal energy and mass. Heat and mass transfer rates, steady and unsteady state conduction, convection, diffusion; design of simple heat exchangers. Application of these topics and fluid mechanics to fluid handling, bacterial growth, plant nutrient uptake, enzymatic reactions. Pre: 3154, ESM 3024. (3H,3C)

3524: UNIT OPERATIONS IN BIOLOGICAL SYSTEMS ENGINEERING
Unit operations for processing biological materials including heat exchangers, evaporation, drying, mixing, homogenization, extrusion, phase and multi-phase separation, and size reduction. Laboratory hands-on experience in various unit operations. Course requirements may be satisfied by taking BSE 3504 prior to or concurrent with course. Co: 3504. (2H,3L,3C)

3534: BIOPROCESS ENGINEERING
Engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Metabolic pathways leading to products, enzyme kinetics, cell growth kinetics, and analysis of bioreactors and fermenters. Co: 3504, (BIOL 2604 or BIOL 2604H). Pre: 3154. Co: BIOL 2604, 3504. (3H,3C)

4125-4126: COMPREHENSIVE DESIGN PROJECT
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126: Complete a comprehensive design project using the team approach, test approach, test prototype, and prepare and present a professional engineering design report. Pre: 3334 or 3524 for 4125; 4125 for 4126. 4125: (1H,3L,2C) 4126: (1H,6L,3C)

4204: INSTRUMENTATION FOR BIOLOGICAL SYSTEMS
Introduction to instrumentation and sensors for measurement and control of biological systems. Sensor response dynamics, data acquisition, sensor selection, signal processing and signal conditioning principles. Experimental determination of velocity, pressure, strain, displacement, forces and chemical constituents. Data analysis focused on uncertainty, error and statistical concepts. Pre: PHYS 2306, ESM 3024. (2H,2L,3C)

4224: FIELD METHODS IN HYDROLOGY
Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrologic processes: water flow, hydrologic conductivity, precipitation, evaporation. Sampling techniques: surface water, groundwater, and soil pore water sampling. In-situ monitoring: automatic samplers, dataloggers, water quality sondes. Laboratory analyses: good laboratory practices, selection of analytical method, calibration, quality assurance/quality control. Co: 3324 or CEE 3314 or FREC 3104 or WATR 3104. (2H,3L,3C)

4304: INTRODUCTION TO WATERSHED MODELING
Fundamental modeling principles used to quantifywatershed hydrology, energy budgets,and associated

ecosystem functions, such asplant dynamics and biogeochemical processes, at scales ranging from soil poresto watersheds. Code development and model integration to simulate watershed hydrologyandnutrient and sediment transport. Model calibration and performance assessment. Data discovery, acquisition, and processing of data relevant to hydrologic/watershed modeling. Pre: 3334, 4344. (2H,3L,3C)

4344: GEOGRAPHIC INFORMATION SYSTEMS FOR ENGINEERS
Conceptual, technical, and operational aspects of geographic information systems as a tool for storage, analysis, and presentation of spatial information. Focus on engineering applications in resource management, site selection, and network analysis. Laboratory work and senior standing required. Pre: 3324 or CEE 3314 or FREC 3104 or WATR 3104. (2H,3L,3C)

4394: WATER SUPPLY AND SANITATION IN DEVELOPING COUNTRIES
Social, economic and engineering principles of water supply and sanitation in developing countries as affected by climate, cultural and sociological factors, and material and financial resources. Pre: Junior or Senior standing. (3H,3C)

4524: BIOLOGICAL PROCESS PLANT DESIGN
Engineering principles for design of systems for processing biological materials into primary and secondary products. Delivery, scheduling, storage requirements, economic analysis. Process control and instrumentation of bioprocessing plants. Pre: 3524. (3H,3C)

4544 (CHE 4544): PROTEIN SEPARATION ENGINEERING
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software. Pre: 3504 or CHE 3144. (3H,3C)

4554 (FREC 4554) (HORT 4554) (LAR 4554) (SPIA 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: HORT 2134 or FREC 2134. (3H,3C)

4564: METABOLIC ENGINEERING
Engineering concepts for analyzing, designing, and modifying metabolic pathways to convert raw materials to food, pharmaceuticals, fuels and chemicals. Cell metabolism, pathway design, bioenergetics, regulatory mechanisms, metabolic modeling, and genetic tools. Pre: 3534. (3H,3C)

4604: FOOD PROCESS ENGINEERING
Analysis and design of food processing operations including thermal pasteurization and sterilization, freezing, extrusion, texturization, and mechanical separation. Pre: 3504, 3524. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Biological Systems Engineering

Interim Head: R. D. Grisso
Professors: J. R. Barone, B. L. Benham, R. D. Grisso, W. C. Hession, S. Mostaghimi, M. L. Wolfe, and C. Zhang
Associate Professors: J. Arogo Ogejo, Z. M. Easton, L.-A. H. Krometis, D.J. Sample, D. Scott, R.S. Senger, V. R. Sridhar, and T. M. Thompson
Assistant Professors: R. C. Wright, J. A. Czuba, and J. E. Shortridge
Instructor: S. C. Mariger

Web: **www.bse.vt.edu**

Overview

The Biological Systems Engineering program integrates biology, chemistry, and physics with engineering to solve engineering problems associated with the environmentally sound production, processing, and utilization of renewable resources. The curriculum differs from other engineering programs in that it focuses on the sustainable production of biological products and the management of natural resources. Biological Systems Engineering graduates have rewarding careers working with biological materials and both large and small biological systems, for the benefit of society and the environment.

The BSE program is designed to graduate engineers who apply engineering principles to biological systems in fields/professions such as biotechnology, watershed science, environmental health, and food engineering. The BSE program prepares graduates to accomplish the following objectives in their careers within a few years after graduation:

- Design solutions to problems at the intersection of biology and engineering at scales ranging from molecular to global.

- Address societal and ecological needs in food and fiber production and processing, biotechnology, pharmaceuticals, green chemicals, renewable energy, environmental protection, and sustainable development.
- Collaborate effectively as members of multidisciplinary teams and communicate effectively across a diversity of audiences.
- Advance professionally through mentoring and life-long learning.

These educational objectives are supported by a curriculum that provides its graduates with:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- an ability to communicate effectively with a range of audiences
- an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

The BSE program provides a strong, broad-based engineering education with opportunity for specialization utilizing the 33 credits of technical electives available in the curriculum. Using these electives, BSE students prepare for careers in biomedical engineering, biotechnology, biopharmaceuticals, food engineering, or watershed science and engineering. Many BSE graduates also choose to pursue graduate studies or professional degrees from medical, veterinary, or dental programs.

Recognizing the importance of "hands-on" experience in engineering education, instructional laboratories are included in many of the Biological Systems Engineering courses. These laboratory courses are designed to enhance understanding of theoretical concepts through hands-on activities. In addition to providing a strong and broad-based engineering education, the program emphasizes communication, team work skills, and design experience. The department participates in the Cooperative Education Program, which gives qualified students valuable work experience while pursuing an undergraduate degree. Students are also encouraged to participate in undergraduate research and study abroad programs. Many BSE students are employed in departmental research laboratories.

Design and teamwork experiences are integral parts of the program. In the second year, students work in teams to design, build, and test a solution to an assigned design problem. Throughout the junior year, students acquire knowledge and analytical skills required for successful and professional engineering design through course assignments. The senior year design sequence gives students a comprehensive design experience in which they utilize much of the knowledge they have acquired through their other courses. Students work in teams to solve "real-life" engineering problems.

The Bachelor of Science in biological systems engineering is offered through the College of Engineering and is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

The relatively small class sizes in Biological Systems Engineering promote excellent interaction between faculty and students.

The department offers over 20 endowed scholarships to students enrolled in Biological Systems Engineering; students are also eligible for College of Engineering and other university scholarships.

In addition to the undergraduate degree program, programs of study leading to master of engineering, Master

of Science, and Ph.D. degrees are available in the department. The BSE department also participates in the Accelerated Undergraduate/Graduate degree program. Through this program, undergraduate students with a GPA of 3.4 or above can apply for admission to the Graduate School during their junior year. If admitted, students may apply up to 12 hours of graduate coursework to both their graduate and undergraduate degree requirements, thus accelerating completion of a master's degree in BSE.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (BSE)

2004: INTRODUCTION TO BIOLOGICAL SYSTEMS ENGINEERING
Introduction to the fundamental concepts of Biological Systems Engineering, including statistics, heat and mass balances, protein separation, microbial metabolism, and enzyme kinetics. Engineering design process, engineering problem-solving tools and techniques, development of oral and written communication skills, and the importance of teamwork and ethics in Biological Systems Engineering. Pre: ENGE 1024 or ENGE 1215 or ENGE 1414. (1H,3L,2C)

2094: INTRODUCTION TO METAL FABRICATION
Introduction to metal working tools, equipment, and processes. Fundamentals of gas and arc welding. (3L,1C)

2294: ANIMAL STRUCTURES AND ENVIRONMENT
Functional considerations in facilities development for production agriculture. Concepts of farmstead planning and system development emphasized. Techniques for providing production animal environment, especially for confinement facilities. Pre: (MATH 1016 or MATH 1025). (3H,3C)

2304: LANDSCAPE MEASUREMENTS AND MODELING
Introduction to land surveying, computer-aided design, and drafting for land and water resources engineering. Representation of features in two and three dimensions for documentation and visualization of watershed engineering projects. Create plans, cross sections, detail drawings, and three dimensional visualizations using computer-aided design and drafting tools. Pre: (MATH 1206 or MATH 1226). (2H,3L,3C)

2484: ENGINE AND POWER TRAIN TECHNOLOGY
Fundamentals of the construction and operation of current internal combustion power units. Control of power utilizing clutches, transmissions, drive shafts, and differentials. Pre: (MATH 1016 or MATH 1025). (2H,3L,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3134: BIOLOGICAL SYSTEMS ENGINEERING SEMINAR
Critical review of technical and professional articles on current topics in Biological Systems Engineering. Development of oral presentation and technical writing skills. Contemporary ethical, professional, and global

issues in Biological Systems Engineering. Pre: 2004. (2L,1C)

3144: ENGINEERING ANALYSIS FOR BIOLOGICAL SYSTEMS USING NUMERICAL METHODS
Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation and numerical solution of ordinary differential equations. Error analysis and programming with engineering software. Course requirements may be satisfied by taking MATH 2214 prior to or concurrent with course. Co: MATH 2214. (2H,2C)

3154: THERMODYNAMICS OF BIOLOGICAL SYSTEMS
Fundamental concepts, first and second laws, psychrometrics applied to plant and animal environments, introduction to Gibbs energy, and application of calorimetry to gain basic understanding of energy flow in a biological system. Course requirements may be satisfied by taking CEE 3304 or CHE 3114 or ESM 3234 or ESM 3024 or ME 3404 prior to or concurrent with course. Pre: ESM 2304, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

3324: SMALL WATERSHED HYDROLOGY
Precipitation, soil physics, infiltration, evapotranspiration, groundwater hydrology, overland flow, open channel flow, flow routing, hydraulic analysis. Course requirements may be satisfied by taking CEE 3304 or CHE 3114 or ESM 3234 or ESM 3024 or ME 3404 prior to or concurrent with course. (3H,3C)

3334: NONPOINT SOURCE POLLUTION ASSESSMENT AND CONTROL
Erosion prediction and control; transport and fate of sediment, nutrients, and microorganisms; design of nutrient management plans, wetlands, detention facilities and other management practices for rural and urban nonpoint source pollution control. Pre: 3324. (2H,3L,3C)

3494: ADVANCED WELDING TECHNOLOGY
Techniques in welding that include gas, submerged metal arc, metal inert gas, pulsed arc, and tungsten inert gas welding. Design of welding structures, fundamentals of heat treatment, and plasma arc cutting. Consent required. (3L,1C)

3504: TRANSPORT PROCESSES IN BIOLOGICAL SYSTEMS
Introduction to material and energy balances in biological systems. Fundamentals of heat and mass transfer in biological systems. One and two dimensional conduction, convection, and diffusion of thermal energy and mass. Heat and mass transfer rates, steady and unsteady state conduction, convection, diffusion; design of simple heat exchangers. Application of these topics and fluid mechanics to fluid handling, bacterial growth, plant nutrient uptake, enzymatic reactions. Pre: 3154, ESM 3024. (3H,3C)

3524: UNIT OPERATIONS IN BIOLOGICAL SYSTEMS ENGINEERING
Unit operations for processing biological materials including heat exchangers, evaporation, drying, mixing, homogenization, extrusion, phase and multi-phase separation, and size reduction. Laboratory hands-on experience in various unit operations. Course requirements may be satisfied by taking BSE 3504 prior to or concurrent with course. Co: 3504. (2H,3L,3C)

3534: BIOPROCESS ENGINEERING
Engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Metabolic pathways leading to products, enzyme kinetics, cell growth kinetics, and analysis of bioreactors and fermenters. Co: 3504, (BIOL 2604 or BIOL 2604H). Pre: 3154. Co: BIOL 2604, 3504. (3H,3C)

4125-4126: COMPREHENSIVE DESIGN PROJECT
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126: Complete a comprehensive design project using the team approach, test approach, test prototype, and prepare and present a professional engineering design report. Pre: 3334 or 3524 for 4125; 4125 for 4126. 4125: (1H,3L,2C) 4126: (1H,6L,3C)

4204: INSTRUMENTATION FOR BIOLOGICAL SYSTEMS
Introduction to instrumentation and sensors for measurement and control of biological systems. Sensor response dynamics, data acquisition, sensor selection, signal processing and signal conditioning principles.

Experimental determination of velocity, pressure, strain, displacement, forces and chemical constituents. Data analysis focused on uncertainty, error and statistical concepts. Pre: PHYS 2306, ESM 3024. (2H,2L,3C)

4224: FIELD METHODS IN HYDROLOGY
Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrologic processes: water flow, hydrologic conductivity, precipitation, evaporation. Sampling techniques: surface water, groundwater, and soil pore water sampling. In-situ monitoring: automatic samplers, dataloggers, water quality sondes. Laboratory analyses: good laboratory practices, selection of analytical method, calibration, quality assurance/quality control. Co: 3324 or CEE 3314 or FREC 3104 or WATR 3104. (2H,3L,3C)

4304: INTRODUCTION TO WATERSHED MODELING
Fundamental modeling principles used to quantifywatershed hydrology, energy budgets,and associated ecosystem functions, such asplant dynamics and biogeochemical processes, at scales ranging from soil poresto watersheds. Code development and model integration to simulate watershed hydrologyandnutrient and sediment transport. Model calibration and performance assessment. Data discovery, acquisition, and processing of data relevant to hydrologic/watershed modeling. Pre: 3334, 4344. (2H,3L,3C)

4344: GEOGRAPHIC INFORMATION SYSTEMS FOR ENGINEERS
Conceptual, technical, and operational aspects of geographic information systems as a tool for storage, analysis, and presentation of spatial information. Focus on engineering applications in resource management, site selection, and network analysis. Laboratory work and senior standing required. Pre: 3324 or CEE 3314 or FREC 3104 or WATR 3104. (2H,3L,3C)

4394: WATER SUPPLY AND SANITATION IN DEVELOPING COUNTRIES
Social, economic and engineering principles of water supply and sanitation in developing countries as affected by climate, cultural and sociological factors, and material and financial resources. Pre: Junior or Senior standing. (3H,3C)

4524: BIOLOGICAL PROCESS PLANT DESIGN
Engineering principles for design of systems for processing biological materials into primary and secondary products. Delivery, scheduling, storage requirements, economic analysis. Process control and instrumentation of bioprocessing plants. Pre: 3524. (3H,3C)

4544 (CHE 4544): PROTEIN SEPARATION ENGINEERING
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software. Pre: 3504 or CHE 3144. (3H,3C)

4554 (FREC 4554) (HORT 4554) (LAR 4554) (SPIA 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: HORT 2134 or FREC 2134. (3H,3C)

4564: METABOLIC ENGINEERING
Engineering concepts for analyzing, designing, and modifying metabolic pathways to convert raw materials to food, pharmaceuticals, fuels and chemicals. Cell metabolism, pathway design, bioenergetics, regulatory mechanisms, metabolic modeling, and genetic tools. Pre: 3534. (3H,3C)

4604: FOOD PROCESS ENGINEERING
Analysis and design of food processing operations including thermal pasteurization and sterilization, freezing, extrusion, texturization, and mechanical separation. Pre: 3504, 3524. (3H,3C)

4974: INDEPENDENT STUDY

Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Civil and Environmental Engineering

Interim Head: M. A. Widdowson
Interim Assistant Head: W.R. Knocke
Interim Assistant Head and David H. Burrows Professor: R.T. Leon
Charles E. Via, Jr. Professor: G.M. Filz
Charles E. Via, Jr. Professor: J. C. Little
Charles P. Lunsford Professor: L.C. Marr
Nick Prillaman Professor: P.J. Vikesland
Samuel Reynolds Pritchard Professor: H.A. Rakha
University Distinguisghed Professor: M.A. Edwards
W. Thomas Rice Professor: A. Pruden
Professors: M.M. Abbas, T.L. Brandon, F.A. Charney, A.M. Dietrich, R.L. Dymond, G.W. Flintsch, D.L. Gallagher, S.B. Grant, R.A. Green, Z. He, J.L. Irish, W.R. Knocke, C.L. Roberts-Wollmann, A. Rodriguez-Marek, S.K. Sinha, A.A. Trani, and L. Wang
Associate Professors: M.R. Eatherton, M.J. Garvin, K.L. Hancock, K.P. Heaslip, E.T. Hester, I.A. Koutromanos, M. Mauldon, N. Stark, and K. Strom
Assistant Professors: A.S. Brand, M.M. Flint, H. Foroutan, M.H. Hebdon, S. Hotle, G. Isaacman-VanWertz, E. Jacques, F. Jazizadeh Karimi, F. Paige, M.A. Rippy, R. Sarlo, M. Shakiba, E.W. Shealy, Z.W. Wang, and A. Yerro Colom
Associate Professors of Practice: J.E. Dove and B.J. Katz
Assistant Professors of Practice: R.P. Scardina, C.M. White, and K. D. Young
Research Associate Professor: A.N. Godrej
Research Assistant Professor: C.C. Hodges
Professors Emeritus: G.D. Boardman, W.E. Cox, D.R. Drew, J. M. Duncan, A. Hobeika, R.C. Hoehn, S.M. Holzer, J.M. Hughes, D.F. Kibler, T. Kuppusamy, J.K. Mitchell, T.M. Murray, J. T. Novak, R. H. Plaut, C.W. Randall, K.B. Rojiani, D. Teodorovic, M.C. Vorster, and R.E. Weyers
Director of Advising: K.E. Lattimer
Coordinator of Alumni and External Relations: C.E. Sakry
Coordinator of Communication Program: M. Wright-Cron

Web: **www.cee.vt.edu**

Overview

The Charles Edward Via, Jr. Department of Civil and Environmental Engineering offers an undergraduate program that facilitates development of critical analytical abilities and the necessary core of knowledge and skills for entry into the civil engineering profession or graduate studies. This body of knowledge includes the scientific procedures for formulating and testing theories and the procedures for applying theory to enhance welfare through engineering analysis, synthesis, and design. The civil engineer plays a key role in the design, construction, maintenance, and management of society's physical infrastructure, including transportation and communication systems, structural facilities for housing human activities, water resource management systems, natural resource development systems, and facilities and programs for environmental protection. The Bachelor of Science program in Civil Engineering is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

Emphasis in civil engineering education is on fundamental principles of science and mathematics and

their application to solving human problems. Civil engineering activities interact in many ways with the natural and social environments within which they take place. Accordingly, the civil engineering program strives to create an awareness of the ecological, social, economic, and political context of engineering and attempts to prepare the civil engineer for the necessary interactions with other professions and the public. An effort to instill an understanding of the role of the civil engineer in satisfying total societal needs is an integral part of the civil engineering program.

Consistent with the general program goal of facilitating development of student competence necessary for entry into engineering practice or graduate school, the Department has developed the following program objectives:

The educational objectives of the Civil Engineering undergraduate program are that, within a few years of program completion, graduates should be effectively serving society as practicing civil engineers and in related capacities with a commitment to design, construction, and maintenance practices that will contribute to sustainable development, provide for the continued well-being of spaces and infrastructure, and hold paramount the health, safety and welfare of the public. Additionally, the program's graduates should continue to grow both technically and professionally so that they develop into leaders within their chosen fields of endeavor. Growth experiences could include activities such as professional licensure, graduate level education, self-directed study, and participation in professional society activities.

The curriculum provides a common freshman and sophomore year, with selection of upper division courses made during course request for the second semester of the sophomore year. The civil engineering curriculum provides breadth across the civil engineering profession and the opportunity for depth within a student's selected specialty areas of interest. Specialty areas offered within the department include: construction engineering & management, environmental engineering, geotechnical engineering, land development, civil engineering materials, structural engineering, transportation engineering, and water resources engineering.

Students are progressively exposed to civil engineering design, culminating in a focused design course experience. The projects assigned in design courses are open-ended, incorporate appropriate engineering standards, and require the application of knowledge from earlier courses in the curriculum. Projects apply technical knowledge to design appropriate physical facilities, but also include consideration of non-technical constraints that confront real-world projects. These additional considerations include such interdisciplinary issues as economics, environmental impact, and sustainability. Accordingly, teamwork and good professional communications skills are a significant part of each design project course experience.

Classroom instruction in the civil engineering program is reinforced by instructional laboratories in the major areas of civil engineering practice. The department seeks to employ the latest educational technology and innovative teaching methods.

The department participates in the Cooperative Education Program in which qualified students may take a semester away from their education to gain valuable professional work experience. The department encourages all students to participate in professional work opportunities prior to graduation.

Contact person for undergraduate Civil and Environmental Engineering programs is Kara Lattimer, CEE Director of Advising at (540) 231-7148 or e-mail: **karalatt@vt.edu**.

Full programs of graduate study are available, leading to the M.Eng., M.S., and Ph.D. in civil engineering. Graduate degree programs concentrate in one of five major areas: construction engineering and management, environmental and water resources engineering, geotechnical engineering, structural engineering and materials, and transportation and infrastructure systems engineering. For details, see the **Graduate Catalog**.

Civil Engineering Program

Admission to a degree program is competitive, with departmental restrictions established each year by the college. Entry into a degree-granting department requires that a student complete all first year required

courses and maintain a competitive GPA. Applicants who begin their freshman year in the College of Engineering and earn a minimum 3.0 overall are guaranteed first choice of major. More information is available through the Engineering Education Department: **www.enge.vt.edu/undergraduate-changing-majors.html**.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **https://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (CEE)

1984: SPECIAL STUDY
Variable credit course.

2804: INTRODUCTION TO CIVIL AND ENVIRONMENTAL ENGINEERING
Overview of the specialty areas within the civil engineering profession, professional engineer licensing, and engineering ethics. Includes recognizing contemporary issues in civil engineering, civil engineering work in the surrounding community, and the impact of civil engineering solutions on society. Emphasizes successful personal business practices for civil engineering professionals, to include the fundamentals of effective oral, written, and visual communication skills for the Civil Engineer. Introduction to engineering library resources. A grade of C- or better required in prerequisite. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804 (3H,3C)

2814: CIVIL AND ENVIRONMENTAL ENGINEERING MEASUREMENTS
Introduction to various data measurement issues in civil and environmental engineering, including collection techniques, analysis, error, and statistical evaluation in all sub-disciplines. Spatial measurement topics include GPS, leveling, distance and angular measurement, mapping and topographic surveys, automated data collection, terrain models, earthwork methods, construction surveying, geodesy, and GIS. A grade of C- or better required in pre-requisites. Pre: BC students required to take the BC 1224 pre-requisite, BC and CEM students are exempt from corequisite CEE 2824. CEE students are required to take the ENGE 1216 pre-requisite. Pre: (ENGE 1114 or ENGE 1216 or ENGE 1414 or BC 1224), (MATH 1206 or MATH 1206H or MATH 1226). Co: 2824. (3H,3L,4C)

2824: CIVIL ENGINEERING DRAWINGS AND CAD
Introduction to the use of Computer-Aided Drafting (CAD) software in civil engineering, construction, and other land development projects. Interpretation of typical civil engineering drawings. Creation of land development plans, cross section and profile drawings, and detail drawings utilizing computer-aided design and drafting tools. Creation of two- and three- dimensional visualizations of civil engineering, construction, and other land development projects. (1H,1C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH

Variable credit course.

3014: CONSTRUCTION MANAGEMENT
Fundamental elements involved in managing construction projects. Management structure, construction contracts, equipment and labor productivity, scheduling, quality assurance, and cost control. Junior standing required. (2H,3L,3C)

3104: INTRODUCTION TO ENVIRONMENTAL ENGINEERING
Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations. A grade of C- or better required in pre-requisites. Pre: CHEM 1035, CHEM 1045, (MATH 1026 or MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024), (PHYS 2305 or PHYS 2205). (3H,3C)

3274: INTRODUCTION TO LAND DEVELOPMENT DESIGN
An introduction to the land development design process including site selection and feasibility, environmental considerations, utility layout, grading, stormwater management and integrating planning with the design of infrastructure to support residential and commercial development. A grade of C- or better in prerequisite. Pre: 2814, (2824 or ENGE 2824). (3H,3C)

3304: FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING
Introductory course in fluid mechanics. Includes concepts and measurements of fluid properties; computing hydrostatic and hydrodynamic forces on hydraulic structures; computing fluid pressures, discharges, and velocities; and determining energy losses in pipe flows. Course includes conducting hydraulic laboratory experiments and demonstrations, analyzing and interpreting collected data, and preparing technical laboratory reports. Emphasizes the fundamentals of effective interpersonal, written, and visual communication skills for technical civil engineering reports. A grade of C- or better in prerequisites. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804 Pre: ESM 2104, CEE 2804. (3H,2L,4C)

3314: WATER RESOURCES ENGINEERING
Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. A grade of C- or better required in prerequisite 3304. Design Lab/Studio. Pre: 3304. (3H,2L,4C)

3404: THEORY OF STRUCTURES
Fundamental tools and methods of structural analysis: moment-area, slope-deflection, force, and moment-distribution methods. Influence lines. Application to beams, trusses, and simple frames. A grade of C- or better required in pre-requisite ESM 2204. Pre: ESM 2204. (3H,3C)

3424: REINFORCED CONCRETE STRUCTURES I
Behavior and design of reinforced concrete members based on ultimate strength. Beams and slabs in flexure, shear and torsion, development of reinforcement. Columns with axial force plus bending, slenderness effects in columns. A grade of C- or better required in prerequisites. Pre: (3404, 3684) or BC 2044. (3H,3C)

3434: DESIGN OF STEEL STRUCTURES I
Behavior and design of structural steel members and steel-frame buildings, including simple and fixed connections. AISC specifications; elastic theory. Design members to resist tension, compression, bending, torsion; plate girders, composite beams. ESM 3054 may be taken in place of co-requisite CEE 3684. A grade of C- or better in prerequisite. Design Lab/Studio. Pre: (3404, 3684) or BC 2044. (3H,2L,4C)

3514: INTRODUCTION TO GEOTECHNICAL ENGINEERING
Engineering properties of soils including their descriptions and classifications, the effects of water, soil strength and compressibility. Introduction to soil stabilization, earth pressures, slope stability, and foundations. A grade of C- or better required in pre-requisites GEOS 2104 and ESM 2204. Design Lab/Studio. Pre: ESM 2204, GEOS 2104. (3H,2L,4C)

3604: INTRODUCTION TO TRANSPORTATION ENGINEERING

Planning, design and operation of transportation systems with emphasis in multimodal transportation techniques and unified system engineering theories to analyze large scale transportation problems. Discussion of Intelligent Vehicle Highway Systems (IVHS) and hands on experience in computer models in transportation operations and planning. Interactions between transportation infrastructure and environmental engineering planning. Junior standing required. (3H,3C)

3684: CIVIL ENGINEERING MATERIALS
Characteristics of constituent materials and the design and behavior of portland cement and bituminous concrete mixtures with demonstrated laboratory experiments. A grade of C- or better required in prerequisites. Design Lab/Studio. Pre: CHEM 1035, CHEM 1045, ESM 2204, CEE 2814, GEOS 2104. (3H,2L,4C)

3804: COMPUTER APPLICATIONS FOR CIVIL AND ENVIRONMENTAL ENGINEERS
Introduction to computer applications in civil and environmental engineering. Integration of quantitative analysis for design, data management, computer programming and problem solving skills with computer tools and techniques. Topics include systems analysis, numerical methods, optimization, data mining, computer programming and data queries. Analysis and interpretation of a global data set. Pre: Junior Standing. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4014 (BC 4024): ESTIMATING, PRODUCTION, AND COST ENGINEERING
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures. A grade of C- or better required in pre-requisite 3014. Pre: 3014. (3H,3C)

4024: CONSTRUCTION CONTROL TECHNIQUES
Techniques used to plan, schedule, and control the Construction Process. Emphasizes manual and computer-based approaches. Focuses on an analytical approach towards the construction process whereby good technical methodologies and solutions are converted to reality through construction practices. A grade of C- or better required in prerequisite. Pre: 3014. (3H,3C)

4074: CONSTRUCTION ENGINEERING: MEANS AND METHODS
Construction means, methods, and equipment used to transform a particular design concept into a completed usable structure or facility. Selection and optimization of individual units as well as the systems needed to produce the required work to the required quality on time and on budget. A grade of C- or better required in prerequisite. Pre: 3014 or CEM 2104. (3H,3C)

4104: WATER AND WASTEWATER TREATMENT DESIGN
Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites. Pre: 3104, 3304. (3H,3C)

4114: FUNDAMENTALS OF PUBLIC HEALTH ENGINEERING
Public health engineering principles for protection against biological and chemical health hazards. Emphasis on major communicable diseases that plague mankind, organisms that cause them, routes of transmission, and engineering methods of control. Appropriate control methods for rural areas and developing countries. A grade of C- or better required in pre-requisite. Pre: 3104. (3H,3C)

4134: ENVIRONMENTAL SUSTAINABILITY - A SYSTEMS APPROACH
Quantitative methods to evaluate environmental sustainability using a sytems approach. Sustainability assessment frameworks, oreintors and indicators, indicators of sustainable development, green-house gas emissions, renewable energy systems, whole-system design, economic systems and input-outpur

techniques, system dynamics models, emergence and agent-based models. Class project requiring integration of environmental, economic and social systems using system dynamics and agent-based models. Senior Standing. Pre: MATH 2214. (3H,3C)

4144: AIR RESOURCES ENGINEERING
Effects, regulation, sources, and control of air pollution. Application of engineering calculations and models to estimate emissions, predict pollutant concentrations, and design pollution control equipment. Senior standing required. A grade of C- or better required in prerequisites. Pre: 3104 or ENGR 3124 or GEOS 3114 or ENSC 3634. (3H,3C)

4174: SOLID AND HAZARDOUS WASTE MANAGEMENT
Introduction to the problems, regulations and techniques associated with the management of solid and hazardous waste. Composition, volume and characterization of the wastes. Design of collection and disposal systems, including landfills, solidification/stabilization and incineration. A grade of C- or better required in pre-requisite 3104. Pre: 3104. (3H,3C)

4254: MUNICIPAL ENGINEERING
An introduction to the field of municipal engineering. Infrastructure, capital projects, financing, sustainability, disaster planning and response, and plan review for development projects. Senior standing required. (3H,3C)

4264: SUSTAINABLE LAND DEVELOPMENT
An introduction to the modern techniques for developing land while maintaining a focus on long-term sustainability. Topics include site layout, stormwater impact, air quality and microclimate, living resources, LEED and EarthCraft development standards. Pre-requisite: Senior Standing required (3H,3C)

4274: LAND DEVELOPMENT DESIGN
Overview of land development projects including factors, construction practices, legal issues, and government policies. Design project includes feasibility study, engineering evaluation of site, and layout design of lots, buildings, streets, sewers, etc. Interactive graphics and automated drafting. Senior standing in Civil Engineering required. A grade of C- or better required in prerequisite. Pre: 3274. (2H,3L,3C)

4284: ADVANCED LAND DEVELOPMENT DESIGN
Advanced course in land development design focusing on site grading and parking, stormwater management, and erosion control. Reviews project design criteria and applicable municipal and state guidelines. Uses CAD software for design and deliverables. Senior/Graduate standing required. A grade of C- or better required in pre-requisites. Pre: 3274. Co: 4274. (3H,3C)

4304: HYDROLOGY
Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in pre-requisite. Pre: 3304. (3H,3C)

4314: GROUNDWATER RESOURCES
Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in pre-requisite 3304. Pre: 3304. (3H,3C)

4324: OPEN CHANNEL FLOW
Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow. Pre: 3314. (3H,3C)

4334: HYDRAULIC STRUCTURES
Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models. A grade of C- or better required in pre-requisite 3314. Pre: 3314. (3H,3C)

4344: WATER RESOURCES PLANNING
Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required. (3H,3C)

4354: ENVIRONMENTAL HYDROLOGY
Overall view of pollutants movements in surface waters, with emphasis on the role of various hydrologic processes. Natural and constructed wetlands and their use for water quality control. Fundamentals of river hydraulics. Design of flood control channels. Environmental consequences of various types of hydraulic systems. Mitigation, enhancement, and restoration techniques. A grade of C- or better required in pre-requisites 3104 and 3314. Pre: 3104, 3314. (3H,3C)

4384: COASTAL ENGINEERING
Basic wave mechanics principles, surf-zone processes, littoral and sediment processes, shoreline features, astronomical tides, coastal hazards, and functional design of coastal structures. Field trips. Pre: C- or better in 3304. Pre: 3304. (3H,3C)

4404: COMPUTER ANALYSIS OF STRUCTURES I
Formulation of matrix displacement method in a form suitable for program development. Application to trusses and frames. Incorporation of special features such as symmetry, internal releases, support settlements, and influence lines. Initiation of program development. Use of existing programs on the personal computer. A grade of C- or better required in pre-requisite 3404. Pre: 3404. (3H,3C)

4454: MASONRY STRUCTURAL DESIGN
Masonry materials, material testing, material specifications. Structural behavior and design of masonry elements (walls, beams, and columns) and systems used in structures. Construction techniques and the details of masonry construction. Building codes relating to analysis and design of masonry structures. A grade of C- or better required in pre-requisites 3424 and 3684. Pre: 3684, 3424. (3H,3C)

4514: METHODS IN GEOTECHNICAL ENGINEERING
Principles and techniques for characterizing earth materials (soil and rock) for civil engineering projects in various regional environments; with emphasis on the interdisciplinary approach to field exploration and site description through soil mechanics theory, geologic correlations, geophysical methods, in site testing and sampling. A grade of C- or better required in pre-requisite 3514. Pre: 3514. (3H,3C)

4534: EARTH PRESSURES AND FOUNDATION STRUCTURES
Earth pressure theories and their applications to the design of retaining structures, anchors, and excavation bracing. Bearing capacity and settlement of shallow foundations. Types and capacity of deep foundations. A grade of C- or better in pre-requisite 3514. Pre: 3514. (3H,3C)

4544: DESIGN OF EARTH STRUCTURES
Application of geotechnical engineering principles in the design and construction of earth structures. Subsurface models, shear strength of soil, slope stability, earth fills, earth retention, ground improvement, sustainability considerations, geotechnical reporting. Team-based design project. C- or better in 3514. Pre: 3514. (3H,3C)

4554: NATURAL DISASTER MITIGATION AND RECOVERY
Causes, mechanics, classifications, and forces associated with tornadoes, hurricanes, floods, earthquakes, and landslides. Resistance evaluation for existing ground, facilities and structures. Hazard-resistant design of new facilities. Risk and reliability assessment and decision analysis. Strategies and designs for natural disaster risk mitigation. Emergency response for protection of life and property and restoration of lifelines. Includes an interdisciplinary team project. Prerequisite: Senior Standing Required (3H,3C)

4564: INTRODUCTION TO COASTAL AND MARINE GEOTECHNICS
Geotechnical aspects of coastal and marine engineering. Introduction to the coastal zone as a working environment. In-situ geotechnical methods and complementary techniques for investigation. Survey strategies. Local field trips for demonstrating methods, practice and design. A grade of C- or better is

required in prerequisite 3514. Pre: 3514. (3H,3C)

4604: TRAFFIC ENGINEERING
Study of traffic and parking characteristics; application of traffic control devices; principles and techniques used to improve the efficiency and safety of traffic flow systems. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4614: ADVANCED STRUCTURAL CONCRETES
Fundamental properties and the physical and chemical aspects of the structure of Portland cement concretes. Emphasis placed on environmental performance aspects and the application of studies of concrete performance under various exposure conditions. A grade of C- or better required in pre-requisite 3684. Pre: 3684 or BC 2044. (3H,3C)

4624: PLANNING TRANSPORTATION FACILITIES
Transportation planning process; urban and regional studies, surveys, data analysis, model development and testing; transportation management, administration, finance, system evaluation, implementation, and integration. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4634: INFRASTRUCTURE CONDITION ASSESSMENT
Infrastructure components and assessment needs; physical and chemical properties of construction materials; deterioration causes, assessment methods, nondestructive evaluation techniques, infrastructure management systems, performance models, service-life-cycle estimates. A grade of C- or better required in pre-requisite 3684. Pre: 3684. (3H,3C)

4654: GEOMETRIC DESIGN OF HIGHWAYS
Functional design of highways; curves, intersections, interchanges, drainage, and other features involved in highway safety and traffic efficiency. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4664: PAVEMENT DESIGN
Principles underlying methods for the design of various elements of flexible and rigid pavements for highways and airports; climate and traffic effects; pavement management systems. A grade of C- or better required in pre-requisite 3684. Pre: 3684. (3H,3C)

4674: AIRPORT PLANNING AND DESIGN
Airport planning and economic justification, site selection, configuration, development and design of terminal areas, demand forecasting, access, traffic control. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4684: TRANSPORTATION SAFETY
Basic principles associated with transportation safety related to humans, vehicles and infrastructure as well as principles of design for safety and practices of empirical evaluation of safety. Principles and practices of accident investigation and injury epidemiology as well as safeguards and control practices. A grade of C- or better required in prerequisite. Pre: 3604. (3H,3C)

4694: FREIGHT OPERATIONS
Introduction to the operation of modal and intermodal freight facilities. Impact of goods movement on the multi-modal transportation system. Role of privately owned and operated goods movement on public sector transportation operations, management, and decision making. Communication of impacts. Pre: 3604. (3H,3C)

4804: PROFESSIONAL AND LEGAL ISSUES IN CIVIL ENGINEERING
An overview of civil engineering professional practice, including business etiquette, professional development, leadership, and lifelong learning. Emphasizes the importance of registration for civil engineers. Compares and contrasts common project delivery methods, processes, key players, and management topics for the design and construction industry. Incorporates analyses of legal and ethical aspects of civil engineering practice. Analyzes contemporary issues and public policies that impact the civil engineering profession, and the impacts of civil engineering solutions on society. Emphasizes effective written, oral, and visual professional communication for the civil engineering professional. A

grade of C- or better in prerequisite. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804 Pre: 2804. Co: 3304. (3H,3C)

4814: RISK AND RELIABILITY ANALYSIS IN CIVIL AND ENVIRONMENTAL ENGINEERING
Risk assessment and reliability analysis as applied to civil engineering applications. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Application of probability and statistics to performance analysis. Development of probabilistic engineering safety assessments. Pre: 3804. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Chemical Engineering

Head: D. F. Cox
Alexander F. Giacco Professor: D.G. Baird
Alumni Distinguished Professor and Frank C. Vilbrandt Professor: Y.A. Liu
Professors: L.E.K. Achenie, R.M. Davis, W.A. Ducker, E. Kiran, and C. Lu
Robert E. Hord Jr. Professor: P. Rajagopalan
Fred W. Bull Professor: C. Lu
Associate Professors: A.S. Goldstein, A.M. Karim, S.M. Martin, and A.R. Whittington
Assistant Professors: M Bortner, S. Deshmukh, R. Tong, H. Xin, and H. Zhu
Adjunct Professors: P.L. Durrill, E.G. Joseph, G.E. Keller II, S.T. Oyama, and P.K. Shin
Joseph H. Collie Distinguished Professor: G. Whiting
Professor Emeritus: W.L. Conger, P.R. Rony, and J.T. Sullivan
ChE Academic Advisor: G. Whiting
ChE Co-op Advisor: G. Whiting

Web: **www.che.vt.edu**

Overview

Skillful and creative applications of the principles of chemistry, biochemistry, biology, mathematics, and physics are needed to solve the problems now confronting society. Whether these problems involve energy, food, health, materials or environmental quality, the modern chemical engineer is the professional concerned with finding economically and socially acceptable solutions. The program prepares graduates for employment in a great variety of industries including specialty chemicals, petroleum, pharmaceutics, paper, fibers, plastics, food, electronics, consumer products, and environmental remediation. Students may customize their academic program around an industry of interest by judiciously selecting electives. Courses in chemistry, polymers,

biotechnology, marketing, and green engineering are common choices.

The objective of the undergraduate program is that within five years of completing their BS degrees, graduates will be successful in a variety of professional careers, including those outside of traditional chemical engineering fields as evidenced by one or more of the following achievements:

- Sustaining a career as a problem solver in engineering or other fields that require analytical skills
- Professional advancement in positions of increasing leadership and/or responsibility within their chosen career field
- Attainment of an advanced degree or advanced certification leading to a career in engineering or science, business, law, medicine, or academia
- Bettering society through professional or personal service

The curriculum has been developed to meet the department goal and the objectives for the graduates. The curriculum is demanding and a GPA of at least 3.0 is recommended for transfer into the program at the sophomore level. An average GPA of at least 2.00 in all CHE courses attempted (except CHE 4144) is required for continued enrollment in the department. The department has specific grade policies for continuation in the program and for graduation. For further information on these policies, please contact the department.

The chemical engineering curriculum integrates studies in thermodynamics, fluid mechanics, heat transfer, mass transfer, process control, reaction kinetics, plant and process design, verbal and written communications, and reaction kinetics, along with professional ethics and environmental awareness. Throughout this curriculum students learn the fundamentals of chemical processing equipment design and operation. In addition, students gain hands-on experience with the equipment during the summer Unit Operations Laboratory. The experience culminates in participation in either a national senior-level design contest or a design project with a local industrial mentor. The laboratory and the senior design courses are recognized as two of the high points in the undergraduate program. The computer is a necessary tool in all the courses and the same software used in industry is used in the design courses.

In addition to the basic undergraduate program outlined here, more sophisticated and specialized programs leading to the M.S. and Ph.D. in chemical engineering also are offered (see **Graduate Catalog**).

The department participates in the Cooperative Education Program whereby qualified students may alternate periods of study with periods of professional employment.

Chemical Engineering Program

A total of 131 semester credits are required for graduation in 2020.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

The following are special focus areas students can use as electives. Lists of approved courses for these focus areas are available in the Department of Chemical Engineering.

- Marketing and Chemical Distribution
- Biochemical Engineering
- Polymers

As part of **progress toward a degree**, students must have a grade of C- or better in all CHE-prefix courses and maintain a minimum in-major GPA of 2.0 or above (not including CHE 4144). If the in-major GPA drops below 2.0 at any time, students will be placed on departmental probation. Students cannot remain on departmental probation for more than two consecutive semesters. In the case that a student has not achieved an in major 2.0 or better after two semesters, the student must transfer out of the department, is prohibited from registering for CHE courses for at least one semester and, after that, only with permission of Chemical Engineering department head. All CHE credits (except CHE 4144) are used to calculate in-major GPA. Questions concerning progress to degree should be directed to Dr. Whiting.

Students who plan to co-op should talk with Dr. Whiting of the Chemical Engineering department.

For **additional information** about the Chemical Engineering curriculum, please contact Dr. Goldstein.

The B.S. degree in Chemical Engineering at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

Undergraduate Course Descriptions (CHE)

2004: CHEMICAL ENGINEERING SOPHOMORE SEMINAR
Career opportunities and current topics of interest in the Chemical Engineering profession. Pass/Fail only. (1H,1C)

2114: MASS AND ENERGY BALANCES
Stoichiometric and composition relationships, behavior of gases, vapor pressures, solubility, mass balances, recycling operations, energy balances, first law of thermodynamics, thermophysics, thermochemistry, fuels and combustion, application to chemical operations. Pre: (MATH 1206 or MATH 1206H or MATH 1226), (CHEM 1036 or CHEM 1036H or CHEM 1056 or CHEM 1056H). (3H,3C)

2164: CHEMICAL ENGINEERING THERMODYNAMICS
First and Second Laws, properties of fluids, properties of homogeneous mixtures; phase equilibria, chemical-reaction equilibria. Grade of C- or better required in prerequisite CHE 2114. Pre: 2114. Co: CHEM 3615. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

3015-3016: PROCESS MEASUREMENT & CONTROL
3015: Common process measurements; applications to theory and practice of automatic control of chemical processes; 3016: Design and laboratory practice underlying the automatic computer control of chemical processes. Pre: (MATH 4564 or MATH 4544) for 3015; MATH 4564 or MATH 4544 for 3016. Co: 2124, 3184, 3044 for 3015; 2124 for 3016. 3015: (3H,3C) 3016: (1H,3L,2C)

3044: HEAT TRANSFER
One and two dimensional conduction, convection, and diffusion of thermal energy; heat transfer rates, steady state and unsteady state conduction, convection; design of heat exchangers; forced and free convection boiling and condensation. Pre: 2164, 3114, (MATH 4544 or MATH 4564). (2H,2C)

3114: FLUID TRANSPORT
Fluid statics, surface tension, fluid dynamics, Newton’s Law of viscosity, momentum transport, laminar and turbulent flow, velocity profiles, flow in pipes, flow around objects, non-Newtonian fluids, design of piping systems, pumps and mixing. Pre: 2114, PHYS 2305, (MATH 2204 or MATH 2224). Co: MATH 4564. (3H,3C)

3124: CHEMICAL ENGINEERING SIMULATIONS AND PROCESS MODELING
Development of strategies to pose and numerically solve sets of algebraic and differential equations that

describe chemical engineering systems and processes. Iterative root finding and optimization approaches to solving non-linear equations, analyze data, and determine best-fit model parameters. Numerical strategies to integrate and differentiate models and data. Approaches to solve ordinary and partial differential equations that describe reaction kinetics, process control, and transport of momentum, heat and mass. Algorithm development, coding, and graphical representation of solutions. (3H,3C) Pre: 2114, MATH 2214. Co: 3114, MATH 4564. (3H,3C)

3134: SEPARATION PROCESSES
Binary separations and multicomponent separations, distillation, batch distillation, extraction, absorption, McCabe-Thiele and Ponchon Savaret methods, short cut methods, design of plate columns, plate and column efficiencies. Pre: 2114, (CHEM 3615 or CHE 2164). (3H,3C)

3144: MASS TRANSFER
Multidimensional molecular diffusion and convection of single and multi-component systems; mass transfer rates; steady state, quasi-steady state and transient mass transfer; effect of reactions on mass transfer; convective mass transfer coefficients; design of stage and continuous gas/liquid contractors, membrane, liquid-liquid and liquid-solid separation processes, artificial kidney and drug delivery systems. Pre: 3114, 2164, (MATH 4544 or MATH 4564). (3H,3C)

3184: CHEMICAL REACTOR ANALYSIS AND DESIGN
Power-law rate expressions, kinetic data, rate constants, Arrhenius equation, design of reactors, reactor behavior. Pre: 2164, (MATH 2214 or MATH 2214H or MATH 4544). Co: 3144, 3044. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4014: CHEMICAL ENGINEERING LABORATORY
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small scale processing equipment. Applications include momentum transfer, heat transfer, mass transfer, and chemical reaction. Use of automatic control and data acquisition. Grade of C- or better in all CHE prefix courses and in-major GPA of 2.0 or better are required. Pre: 3015, 3044, 3134, 3144, 3184, (2124 or 3124), ENGL 3764. (15L,5C)

4104: PROCESS MATERIALS
Basics of materials science as it relates to the interest of the chemical engineer. The course emphasizes the three fundamental areas of material science being polymer materials, metallics, and ceramic/inorganic glasses. The general molecular structure property - application behavior of each area will be presented but with a focus when possible on topics related to the field of chemical engineering. Pre: 2164, (CHEM 2535 or CHEM 2565). (3H,3C)

4134: CHEMICAL PROCESS MODELING
Mathematical modeling of chemical processes, application of numerical techniques to the solution of equations, use of a programming language to write programs for calling numerical subroutines, numerical solutions of problems resulting in partial differential equations. Pre: 2124, 3114. Co: 3044, 3184, 3144. (2H,2C)

4144 (MKTG 4144): BUSINESS AND MARKETING STRATEGIES FOR THE PROCESS INDUSTRIES
Business strategies and industrial marketing concepts, and their application in the chemical, pharmaceutical and related process industries. The course is designed for engineers and other students planning a career in the process industries. Junior standing required. Pre: ECON 2005. (3H,3C)

4185-4186: PROCESS AND PLANT DESIGN
Chemical process synthesis and plant design, economic analysis of alternative processes, process equipment design and specifications, computer-aided process design and simulation, design case studies, application of scientific and engineering knowledge to practical design problems. Grade of C- or better in all CHE prefix courses and in-major GPA of 2.0 or better is required. Pre: 3144, 3134, 3184, 3044, 4014 for 4185; 4185 for 4186. (4H,4C)

4214: INTRODUCTION TO POLYMER MATERIALS

Basics of polymeric materials including description and categorization of macromolecules; characterization; mechanical properties; rubbery, glassy, crystalline, and viscous flow behavior. Pre: CHEM 2536, CHE 2164. (3H,3C)

4224: INTRODUCTION TO POLYMER PROCESSING
Basic principles of momentum and heat transfer applied to the analysis of polymer processing operations. Introduction to polymer rheology. Pre: 3144, 3044. (3H,3C)

4304 (ME 4344): BIOLOGICAL TRANSPORT PHENOMENA
Engineering analysis and predictive modeling of heat and mass transport in biological systems (e.g., tissues, organs, organisms, and biomedical devices). Examination of processes that involve conduction, convection, diffusion, generation/ consumption. Application of analytical and computational methods to solve differential equations that describe unsteady and/or multi-dimensional transport. Topics include oxygen transport, pharmacokinetic analysis, kidney function, blood perfusion, burns, and cryopreservation. Pre: (3114, 3044, 3144) or (ME 3304, ME 3404) or (CHE 3114, CHE 3044, CHE 3144) or (M E 3304, ME 3404). (3H,3C)

4334: INTRODUCTION TO COLLOIDAL AND INTERFACIAL SCIENCE
Properties and behavior of colloidal systems, primarily in liquid environments. Size characterization and description, Brownian motion, interparticle forces, dispersion stability, and experimental techniques for characterizing these systems. Pre: 2164, 3144. (3H,3C)

4544 (BSE 4544): PROTEIN SEPARATION ENGINEERING
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software. Pre: BSE 3504 or CHE 3144. (3H,3C)

4904: PROJECT AND REPORT
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors course Variable credit course.

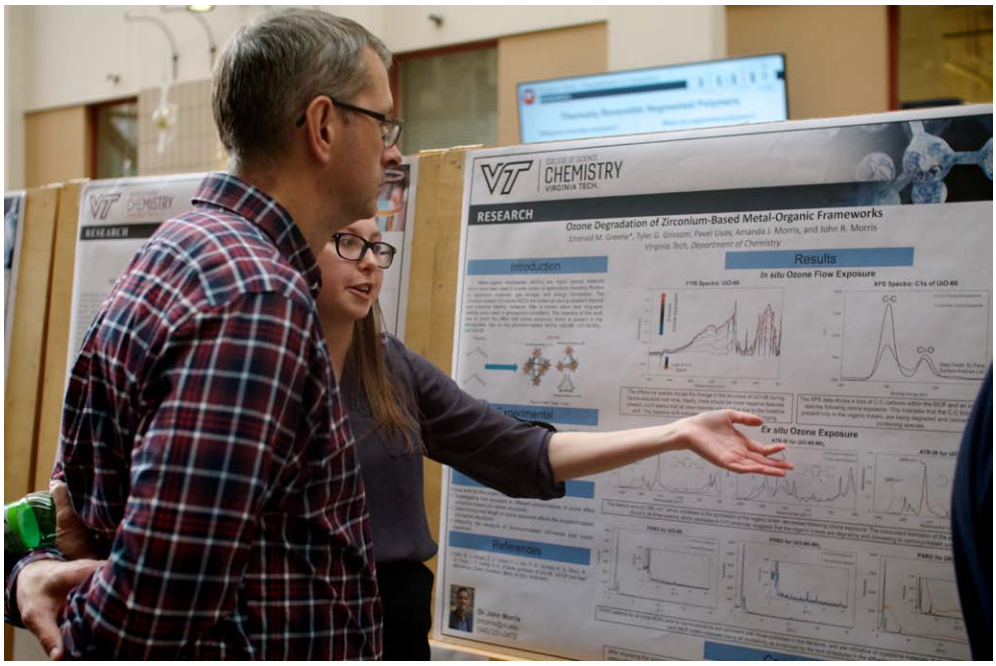
Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Chemistry

Chair: A. R. Esker
Associate Chair: A. J. Morris
University Distinguished Professors: D.G.I. Kingston and T. D. Crawford
Ethyl Corporation Chaired Professor: T. D. Crawford
Professors: P. Carlier, H. C. Dorn, A. R. Esker, F. A. Etzkorn, R. D. Gandour, T. E. Long, L. A. Madsen, J. S. Merola, R. B. Moore, J. R. Morris, J. M. Tanko, and E. F. Valeev
Associate Professors: P. G. Amateis, P. A. Deck, G. L. Long, A. J. Morris, W. L. Santos, B. M. Tissue, D. Troya, and G. T. Yee
Assistant Professors: J. S. Josan, F. Lin, G. G. Liu, A. Lowell, J. B. Matson, N. Mayhall, M. Shulz, and V. V. Welborn
Research Associate Professor: C. Slebodnick
Senior Instructors: M. B. Bump and J. E. Eddleton
Advanced Instructors: S. M. Arachchige, M. A. Berg, and V. K. Long
Instructors: A. Geller, K. Neidigh, E. B. Orler, C. Santos, and C. Wall
Director of Graduate Programs: J. R. Morris
Graduate Program Coordinator: J. Huynh
Director of Undergraduate Programs: P. G. Amateis
Undergraduate Program Coordinator: A. Kokkinakos
Director of General Chemistry: P. G. Amateis

Web: **www.chem.vt.edu**



Overview

The Chemistry Department offers four undergraduate programs: the B.S. in Chemistry, the B.S. in Medicinal Chemistry, the B.S. in Polymer Chemistry, and the B.A. in Chemistry. The B.S. in Chemistry curriculum provides the breadth and depth to give graduates a wide choice of career options, including further graduate studies. The Chemistry Department is accredited by the American Chemical Society's Committee on Professional Training and the B.S. Chemistry degree meets the guidelines for an ACS-certified degree. The B.S. in Medicinal Chemistry prepares students for enrollment in health professional schools or for careers in the pharmaceutical industry. The B.S. in Polymer Chemistry has a concentration in the area of polymer and material sciences. The B.A. program has fewer required chemistry courses, allowing students to design a chemistry program with more electives to meet a wider set of career goals. The B.A. is often chosen by students who wish to pursue a double major or to take other courses to prepare for professional school, law, or business. Any of the degrees are suitable to prepare for high school teaching. The Chemistry Department supports and encourages all chemistry majors to pursue undergraduate research sometime during their degree program.

Graduate Program

The Department offers M.S. and Ph.D. degrees with specializations in many areas of chemistry. (See the Graduate Catalog for further information.)

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor Requirements

The requirements to earn a minor in Chemistry can be found on the specific checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education/Pathways to General Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.A. and B.S. in Chemistry, the B.S. in Medicinal Chemistry, and the B.S. in Polymer Chemistry can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (CHEM)

1004: FIRST YEAR EXPERIENCE IN CHEMISTRY
Orientation to the Chemistry Department and to the discipline of chemistry for chemistry majors and for individuals considering CHEM as a major, including transfer students. Resources for success, both generally as a college student and specifically as a chemistry major. Opportunities for mentoring, individual research and community involvement across the university and within the Chemistry Department. Exploration of career pathways for chemistry majors. Interconnections among professional practice, disciplinary progress, accepted standards for ethical use of information, principles of diversity and inclusion, and individual or personal value systems. Scientific communication, professional networking, and chemistry in the public eye. (1H,1C)

1014: CALCULATIONS IN CHEMISTRY
Mathematical problem solving skills required for success in general chemistry. Manipulation of symbolic algebraic formulas. Dimensional analysis and narrative mathematical exercises. Application of problem solving techniques to chemical processes and reactions. Generation and interpretation of graphs using computer software. Elementary features of atoms, molecules, and the periodic table of the elements. Molar quantities, chemical nomenclature, reaction stoichiometry, and introductory solution chemistry. (3H,3C)

1015,1016: CHEMISTRY IN CONTEXT
Survey of chemistry across areas of specialization for students enrolled in curricula other than science and engineering. History and fundamental concepts and theories of chemistry, including the consequences of changes in parameters on chemical systems. Impact of chemistry in the context of areas of public concern and policy, including best practices for sustainability, rational decision-making, ethical use of scientific information, product and process stewardship. Chemistry as a basis for decision-making in the context of individual values and beliefs, and the roles of values and beliefs in the progress of chemistry as a human endeavor. The foregoing to be based on the concepts of chemistry as follows: 1015: Periodicity and atomic structure; nuclear chemistry; chemical bonding and reactivity; organic chemistry, polymer chemistry, and medicinal chemistry. 1016: Chemical stoichiometry including conservation of matter and energy; acid-base and oxidation-reduction chemistry of solutions; stoichiometry and thermodynamics, agricultural and environmental chemistry, chemistry of household and personal care products (3H,3C)

1025,1026: INTRODUCTION TO CHEMISTRY LABORATORY
Virtual laboratory exercises and reading and writing assignments designed to accompany 1015 and 1016, as applicable. Illustrates and elaborates on principles addressed in lecture, including history and fundamental concepts, theories, contexts, with an emphasis on sustainability issues and ethical

consequences of decision- making in chemistry. Students will identify foundational concepts in chemistry, enumerate parameters likely to influence the outcome of an experiment, analyze the ways that values and beliefs influence progress in the discipline and communicate chemical concepts to a lay audience. (3L,1C)

1034: GENERAL CHEMISTRY RECITATION
A companion course for students needing supplemental help with mathematical and problem-solving skills required for CHEM 1035 General Chemistry. Manipulation of algebraic formulas. Application of problem-solving techniques to chemical processes and reactions. Quantitative methods applied to unit conversions, reaction yields, energy of reactions, and gas properties. Examination of atomic structure, periodicity, and molecular bonding. May not count towards degree requirements; consult advisor. Pass/Fail only. Co: 1035. (1H,1C)

1035-1036: GENERAL CHEMISTRY
First chemistry course for students in science curricula. Applications of reasoning in the natural sciences using chemical laws in an applied context and in the student\031s own discipline. Overview of the universal aspects of chemistry and of application of chemistry to address global challenges. 1035: Problem-solving, elements and periodic table, stoichiometry of chemical reactions, gas phase of matter, energy flow and chemical change, atomic structure, and theories of chemical bonding. 1036: Kinetics, equilibrium, thermodynamics, electrochemistry, transition elements, nuclear chemistry. (Duplicates 1015-1016.) Co: MATH 1025 or MATH 1225. (3H,3C)

1045-1046: GENERAL CHEMISTRY LABORATORY
Hands-on, real-world activities that illustrate and elaborate on concepts taught in general chemistry lecture (1035-1036), including acids and bases, heat capacity, ideal gases, states of matter, concentration, mixtures, energy flow and spontaneity in processes, equilibrium, kinetics, colligative properties, and electrochemistry. Use of instrumentation to analyze water and soil contaminants, biofuel mixtures, nanoparticles, and polymer properties. Laboratory safety, chemical hygiene, hazard mitigation, waste management, and the influence of procedure on experimental outcomes. Global challenges, including recycling and sustainable energy sources, water resource management, global warming, and environmentally friendly reagents in chemical contexts. Use of computers in data analysis, collaboration, and report-writing. Co: 1035 for 1045; 1036 for 1046. (3L,1C)

1055-1056: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor. Co: MATH 1025 or 1225 and CHEM 1065 for 1055. Co: 1065 for 1055; 1066, 1066 for 1056. (4H,4C)

1055H-1056H: HONORS GENERAL CHEM FOR MAJORS
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. Co: MATH 1025 or 1225 and CHEM 1065 for 1055. Co: 1065 for 1055H; 1066, 1066 for 1056H. (4H,4C)

1065-1066: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS LAB
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor. Co: 1055 for 1065; 1056 for 1066. (3L,1C)

2114: ANALYTICAL CHEMISTRY
A first course in analytical chemistry. Topics covered include volumetric and gravimetric analysis, and elementary spectroscopy. Pre: 1036 or 1056 or 1056H. Co: 2124. (3H,3C)

2124: ANALYTICAL CHEMISTRY LABORATORY TECHNIQUES AND PRACTICE
Practical introduction to wet methods of quantitative chemical analysis based on fundamental chemical principles. Prior credit for OR concurrent registration of 2114 lecture is required for 2124 lab. Pre: (1046

or 1066). Co: 2114. (3L,1C)

2154: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS
A one-semester course in analytical chemistry emphasizing the principles of equilibrium with examples from acid-base, complexation, solubility, and redox chemistry. The course also introduces the principles of spectroscopic, electrochemical, and chromatographic instrumentation. Pre: 1036 or 1056 or 1056H. Co: 2164. (4H,4C)

2164: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS LAB
A one-semester laboratory course in analytical chemistry that provides practical training in wet chemical methods, atomic and molecular spectroscopy, electrochemistry, and separations. Pre: 1046 or 1066. Co: 2154. (3L,1C)

2424: DESCRIPTIVE INORGANIC CHEMISTRY
Application of fundamental principles in a systematic study of bonding and reactivity of the elements and their compounds. Pre: 1036 or 1056. (3H,3C)

2514: SURVEY OF ORGANIC CHEMISTRY
Short course in fundamentals of organic chemistry with emphasis on nomenclature, isomerism, and properties of organic compounds. Compounds of importance to biology and biochemistry stressed. (Prior credit for 2535 precludes credit for this course.) One year of Chemistry required. Pre: (1035 or 1055 or 1055H), (1036 or 1056 or 1056H), (1045 or 1065), (1046 or 1066). (3H,3C)

2535-2536: ORGANIC CHEMISTRY
Structure, stereochemistry, reactions, and synthesis of organic compounds. Pre: 1036 or 1056 or 1056H or ISC 1106 or ISC 1106H for 2535; 2535 or (2565 or 2565H) for 2536. (3H,3C)

2545-2546: ORGANIC CHEMISTRY LABORATORY
The laboratory accompanies lectures in organic chemistry 2535 and 2536. Pre: 1046 or 1066 or ISC 1116 for 2545; 2545 for 2546. Co: 2565, 2535 for 2545; 2536 for 2546. (3L,1C)

2555-2556: ORGANIC SYNTHESIS AND TECHNIQUES LAB
Synthesis and characterization of organic compounds using modern laboratory techniques. Pre: 2565 for 2555; 2555 for 2556. (6L,2C)

2565-2566: PRINCIPLES OF ORGANIC CHEMISTRY
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses. Pre: 1036 or 1056 or 1036H or 1056H for 2565; 2565 for 2566. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3615-3616: PHYSICAL CHEMISTRY
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partly duplicates 4615, cannot receive credit for both 3615 and 4615. Pre: (1035 or 1055 or 1055H), (1036 or 1056 or 1056H), PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2224) for 3615; MATH 2214, (CHEM 3615 or CHEM 3615H), (CHEM 3615, MATH 2214 or CHEM 3615H) for 3616. (3H,3C)

3615H-3616H: HONORS PHYSICAL CHEMISTRY
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partially duplicates 4615, cannot receive credit for both 3615H and 4615. 3615H requires additional work; consult the instructor. Pre: (1035 or 1055 or 1055H), (1036 or 1056 or 1056H), PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2224) for 3615H; MATH 2214, (CHEM 3615 or CHEM 3615H), (CHEM 3615, MATH 2214 or CHEM 3615H) for 3616H. (3H,3C)

3625-3626: PHYSICAL CHEMISTRY LABORATORY
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed. Pre: 3615 or 3615H or 4615 for 3625; (3616 or 3616H or 4616), 3625, 4014 for 3626. (3L,1C)

4014: SURVEY OF CHEMICAL LITERATURE
Use of the chemical literature as an aid to professional activities. Pre: Junior Major Standing. (1H,1C)

4054: CAPSTONE IN MATERIALS AND SOCIETY
Capstone course for the Materials and Society Pathways Minor. Synthesizes the students' preparation in social equity, policy, and fundamental materials science to critically analyze concepts in the modern scientific materials landscape, including the evaluation of scientific information, the reciprocal impact of science and society, and the ethics of extraction & mining, manufacturing & use, and disposal of materials. Cultivates skills in teamwork, written and oral presentations, and proposal development. (3H,3C)

4074 (MSE 4544): LABORATORY IN POLYMER SCIENCE
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems. Pre: 3616, 4534. (1H,3L,2C)

4114: INSTRUMENTAL ANALYSIS
Principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the corequisite lab 4124. Pre: (3615 or 3615H), 2154. Co: 4124. (3H,3C)

4114H: HONORS INSTRUMENTAL ANALYSIS
Pre: (3615 or 3615H), 2154. Co: 4124. (3H,3C)

4124: INSTRUMENTAL ANALYSIS LABORATORY
Hands-on experience with modern instrumental methods of analysis. Experiments use spectroscopy, electrochemistry, and separations. Co: 4114. (3L,1C)

4404: PHYSICAL INORGANIC CHEMISTRY
A study of spectroscopic, bonding, and structural properties of inorganic compounds. Pre: (3616 or 3616H), 2424. (3H,3C)

4414: INORGANIC CHEMISTRY LAB Synthesis and characterization of inorganic compounds using modern laboratory techniques. Pre: 2424, (3616 or 3616H), 4404. Co: 4424, 3616. (6L,2C)

4424 (SBIO 4424): POLYSACCHARIDE CHEMISTRY
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials. Pre: 2536 or 2566. (3H,3C)

4434: ORGANOMETALLIC CHEMISTRY

Synthesis, structure, properties, and reactivity patterns of main-group and transitionmetal organometallic compounds. Applications of organometallic compounds in chemical synthesis and catalysis. Pre: 2424, 2565, 2566, 4404. (3H,3C)

4444: BIOINORGANIC CHEMISTRY
Principles underpinning the study of metal ions in biological systems. Review of basic coordination chemistry. Evolution of the distribution of metal ions in biology. Uptake of metal ions from the environment into living organisms. Regulation of metal ion concentrations in cells. Central functions of metal ions in biological systems including modulation of structure, electron transfer reactions, substrate binding and activation, and selective transfer of atoms and groups. Roles of biopolymers in the binding, regulation, and function of metal ions. Physical methods of analysis relevant to bioinorganic chemical research questions. Senior standing. Pre: (2566 or BCHM 4115), BIOL 1105, BIOL 1106. (3H,3C)

4514: GREEN CHEMISTRY
Sustainability, waste prevention, conservation of energy resources, avoidance of toxins, pollutants, and hazards in chemical processes and products. Life-cycle analysis applied to case studies involving process development and product stewardship. Applications in chemical industry, process and product design, and public policy. Pre: 2536 or 2566. (3H,3C)

4524: IDENTIFICATION OF ORGANIC COMPOUNDS
Structure determination of organic compounds by spectroscopic methods, with an emphasis on mass spectrometry and nuclear magnetic resonance. Course will emphasize problem-solving skills. Pre: (2536 or 2566), (3616 or 3616H or 4616). (3H,3C)

4534: ORGANIC CHEMISTRY OF POLYMERS
Structure, synthesis, and basic characteristics of the major classes of polymerization reactions including step-growth (condensation) and chain growth (addition), free radical, and ionic mechanisms. Pre: 2536 or 2566. (3H,3C)

4544: MEDICINAL CHEMISTRY CAPSTONE LABORATORY
Laboratory experience tracing a standard pathway that potential drug targets follow in many medicinal chemistry laboratories. Synthesis of potential drug compounds and verification of their purity and structural identity primarily using mass spectrometry and nuclear magnetic resonance (NMR) spectroscopy. Optimization of conditions for a biochemical assay and verification of its reproducibility. Use of an optimized assay to measure the potency of potential drug compounds to achieve a desired biochemical effect. Application of structure-activity relationships to propose new chemical structures that might show further improvements in potency. Best practices in laboratory safety, chemical hygiene, note-keeping, and professional report-writing. Senior standing. Pre: 4584, BIOL 1105, BIOL 1106. (6L,2C)

4554: DRUG CHEMISTRY
Structure, synthesis, and physiological effects of major classes of pharmaceutical agents including CNS depressants and stimulants, analgesics, anesthetics, cardiovascular agents, chemotherapeutic drugs, and oral contraceptives. Pre: 2536 or 2566. (3H,3C)

4584: BIOORGANIC CHEMISTRY
The organic chemistry underlying the structure and properties of amino acids, peptides, and nucleic acids. Mechanisms of enzyme catalysis and coenzyme-mediated reactions. Mechanisms and thermodynamics of catabolism and anabolism of fats, carbohydrates, and proteins, and of other key biological reactions. Principles of solid-phase synthesis applied to peptides and nucleic acids. Biosynthesis of lipids, sugars, and terpenoids. Pre: 2536 or 2566. (3H,3C)

4615-4616: PHYSICAL CHEMISTRY FOR THE LIFE SCIENCES
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3615, cannot receive credit for 3615 and 4615. Pre: (1036 or 1056 or 1056H), (MATH 1026 or MATH 1226), (PHYS 2206 or PHYS 2306) for 4615; 4615 for 4616. (3H,3C)

4634 (MSE 4534): POLYMER AND SURFACE CHEMISTRY

Physical chemical fundamentals of polymers and surfaces including adhesives and sealants. Pre: 3615 or 4615. (3H,3C)

4734 (CSES 4734) (ENSC 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: CSES 3114, CSES 3124, (CHEM 2514 or CHEM 2535), (CHEM 2114 or CHEM 2154), (MATH 2016 or MATH 1026 or MATH 1226). (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Curriculum for Liberal Education (CLE)

Why We Have It

As a vital component of undergraduate education at Virginia Tech, the Curriculum for Liberal Education (CLE)--required of all undergraduates--empowers our students with a broad base of knowledge and transferable skills. Liberal Education provides students the opportunity for rigorous intellectual encounters with enduring human challenges and important contemporary problems, through wide-ranging exposure to multiple disciplines and ways of knowing.

Through the study of the Sciences, Mathematics, Social Sciences, Histories, Languages and the Arts, the CLE is designed to foster and develop intellectual curiosity and critical thinking; strong analytic, communication, quantitative, and information literacy skills; the capacity for collaboration and creative problem solving; the ability to synthesize and transfer knowledge; intercultural knowledge and understanding; and ethical reasoning and action. The CLE seeks to create the conditions for growing creative and intellectual engagement; civic, personal, and social responsibility; and lifelong learning.

What Students Will Gain

A liberal education offers 21st century students the foundations of what they need to live and thrive as citizens in a globally engaged democracy, a knowledge-intensive economy, and a society where new ideas and understandings are essential to progress. The success of today's college students in their communities, workplaces, and across their lifetimes depends upon a complex and transferable set of skills and capacities. In their lives and in their careers, our students must be prepared to grasp complex problems, develop a global perspective on the diversity of human experience and knowledge, respond to changing demands, and articulate innovative responses and solutions. Today's students are very likely to change jobs and even careers several times over the course of their lives; and certainly, their roles and responsibilities in their families and communities will change and evolve over their lifetimes as well.

The breadth of a rigorous liberal education combined with the depth of specialized study in the student's primary academic discipline(s)--and evidenced in a demonstrated capacity to adapt and transfer knowledge, skills, and responsibilities to new settings and questions--is essential to the education of the whole student

and sets the stage for a lifetime of learning and growth.

Curriculum for Liberal Education (CLE) Areas of Study

Because the Curriculum for Liberal Education is a "living curriculum," there will be some changes from year to year. Courses added to the CLE offerings are generally available to students immediately after being approved. Some requirements of the CLE are phased in over a multi-year period. Thus, it is essential that students continue to consult with their advisors. Please visit the CLE homepage at **http://www.cle.prov.vt.edu/** for more information, and for the *Curriculum for Liberal Education Guides*.

Areas of Study

Area 1: Writing and Discourse	6 Credit Hours
Area 2: Ideas, Cultural Traditions, and Values	6 Credit Hours
Area 3: Society and Human Behavior	6 Credit Hours
Area 4: Scientific Reasoning and Discovery	6 or 8 Credit Hours
Area 5: Quantitative and Symbolic Reasoning	6 Credit Hours
Area 6: Creativity and Aesthetic Experience	1 or 3 Credit Hours
Area 7: Critical Issues in a Global Context	3 Credit Hours
**Students should consult with their advisors about specific college or departmental requirements in these areas.	

Area 1: Writing and Discourse

6 credit hours (2 courses) selected from approved CLE courses. Students who entered the university prior to Fall 2005 and maintain continuous enrollment until graduation must meet the previous Writing Intensive (WI) requirement.

Area 1 requirements reflect the centrality of discourse in the larger intellectual community. Our first-year writing courses introduce students to the interrelated and shared modes of verbal communication that are distinctive to college life - argument, interpretation, analysis, and metaphor - and whose various usages substantially delineate what it means to become broadly educated. These beginning courses should be thought of as the springboard for further writing and discourse throughout the undergraduate curriculum, especially in the disciplinary concentration.

In order to enable students to meet the aims of both liberal education and of professional preparation, we include writing in many courses throughout the university, even if it may not be the main intellectual capacity emphasized in the course. Students are encouraged to seek out courses that offer frequent opportunities for writing and related forms of discourse, both for the enhanced learning these courses can offer and for their bene t in terms of professional preparation. Many courses in the Curriculum for Liberal Education build upon the writing and oral skills that are the direct goal of Area 1 by including a significant writing component and by encouraging the achievement of excellence in communicating ideas and knowledge.

Formerly, the CLE required writing-intensive (WI) courses to support the development of students' writing skills across the undergraduate career. To better facilitate and broaden this goal, the requirement evolved into a departmental requirement for Visual, Spoken and Written Expression (ViEWS). Development of these competencies may be fostered through specific courses in the major, courses outside the major, and/or previously designated WI courses.

Students may meet the first-year writing requirement in one of three ways:

- By successful completion of the two-semester sequence, ENGL 1105-1106 or COMM 1015-1016
- By successful completion of ENGL 1106 for students who are awarded Advanced Standing (based on standardized test scores and high school class rank) and are placed in ENGL 1106. Advanced Standing

students who complete ENGL 1106 at Virginia Tech in the rst enrollment with a C- or better receive Advanced Standing credit for ENGL 1105;
- By successful completion of 1204H for students who meet University Honors Standards or English Department Honors Standards. Honors students who successfully complete ENGL 1204H at Virginia Tech in the rst enrollment with a C- or better receive Advanced Standing credit for ENGL 1105.

Other Information: Virginia Tech accepts ETS Advanced Placement credit for the Freshman Writing sequence.

Area 2: Ideas, Cultural Traditions, and Values

6 credit hours (2 courses) selected from approved CLE courses.

Every student should be introduced to some of the ideas, cultural traditions, and values that have shaped the human world we now inhabit. An educated person sees the present in connection with the past, and understands that presently prevailing values and meanings derive from the creative thought and action of men and women who have preceded us. A study of in uential texts, ideas, representative works of art and technology, and the development of cultural traditions begins to free the student from the super cial fads of the moment and from narrow provincialisms. By examining some of the enduring ideas about human nature and achievement past and present, the individual gains a greater degree of self- knowledge and is better able to formulate worthwhile aims and commitments.

Courses in this curricular area take the human condition and human values as their main focus, while dealing with a range of subject matters: philosophy, literature and communication, history, religion, the arts, and technology. Most of these courses deal with some aspect of Western cultural experience in its numerous varieties. Relatively neglected dimensions of this experience such as the experience of women and minorities will be acknowledged and dealt with, both as an integral aspect of many existing courses and in separate courses which focus directly upon these dimensions. The foreign language courses approved for Area 2 explore the literatures of other countries in their cultural contexts. Moreover, since we are living in an increasingly global cultural context, courses are included that introduce the student to formative non-Western ideas, arts, and traditions as well.

Area 3: Society and Human Behavior

6 credit hours (2 courses) selected from approved CLE courses.

Human beings are not only participants in the world of human culture; we are also observers of it. The cultivation of systematic approaches to the study of humanity is one of the great achievements of the human intellect. Every student should therefore be introduced to the sciences of society and human behavior, a goal that can be accomplished through several avenues: through the study of psychology; through the study of social structures such as government, family, community, or economy; or through more wide-ranging examination of social patterns and processes. Such studies may examine past as well as present, non-Western as well as Western societies.

Courses in this curricular area are best characterized by their methods of study and theoretical frameworks. They look for regularities in human behavior rather than giving primary attention to the unique or non-repeatable aspects of life. When varied human values and allegiances nevertheless make their appearance within these disciplines, they do so more as objects to be investigated than as commitments to be honored.

Area 4: Scientific Reasoning and Discovery

6 credit hours (2 courses) of lecture selected from approved CLE courses. Some majors require 2 credit hours of related laboratory (2 labs).

For many students at Virginia Tech, acquiring detailed knowledge of one or more of the natural sciences is essential. But for all students, a liberal education involves the study of what science is, of how it can be conducted, of what it can and cannot tell us about the world. Without scientific study and the experience offered by a laboratory, students perceive only vaguely how and why science functions as a crucial standard for knowledge and inquiry in modern life. The study of a science engages the student in analysis and

deduction as well as empirical experimentation - that is, in scientific reasoning and discovery.

The impact of the natural sciences and technology on our globally interdependent world is one of the most important realities we face as we enter the 21st century. The science courses in the CLE have a special role in educating students about the critical relevance of scientific knowledge to the potentialities and dilemmas of our natural and social environments.

Area 5: Quantitative and Symbolic Reasoning

6 credit hours (2 courses) selected from approved CLE courses

Like writing, mathematics is essential to intellectual inquiry in many areas. It is a basic language of the natural and social sciences and has become a useful tool for research in the humanities. The technological uses of mathematics and related forms of symbolic analysis are of tremendous significance to human society. Furthermore, the history of quantitative and symbolic reasoning as an intellectual discipline is linked with philosophy, the arts, and other aspects of human culture. Thus, a broad education must include these forms of reasoning, both as skills and as central modes of thought. Mathematics, statistics, and certain areas of computer science and philosophy can all contribute to broadening a student's knowledge of quantitative and symbolic reasoning.

A diagnostic formula and testing procedure has been derived to predict readiness for Engineering/Science Calculus at Virginia Tech. A purpose of MATH 1015 is to serve those students who need further preparation. You can obtain information about the math diagnostic test from your advisor.

Many departments throughout the university have specific math sequence requirements. Be sure to check with your advisor about the requirements for your program.

Area 6: Creativity and Aesthetic Experience

1 or 3 credit hours selected from approved CLE courses. Students in the College of Science and most majors in the College of Liberal Arts and Human Sciences must take one (1) 3-credit hour course. Students should consult with their advisors about specific college or departmental requirements.

The arts contribute significantly both to the experience and the interpretation of human life. Creativity and aesthetic response criss-cross the boundaries among intellectual ideas, the imagination, and actual design. Moreover, the arts are always intimately linked with the material culture of a society — its modes of production and design — as well as with its values and ideas. Thus, the arts can be studied and experienced in a variety of ways: as "high culture," as a means of tracing the history and ideas of particular societies, and as an active process of creative design and expression in many different physical forms. The metaphorical and intuitive thought processes that are essential to making and experiencing works of art are woven into many other human cultural and creative activities. Thus, the arts have an important role to play in broadening our aesthetic and intellectual sensibilities. Most artistic media include a highly public dimension - concerts, exhibitions, performances, publications, public installations, and the built environment - in which the creative works of artists, designers, and their collaborators are accepted or contested as meaningful elements of the larger social fabric. A guided exposure to the arts can provide a valuable framework for continued appreciation of, and participation in, the arts beyond college.

Area 7: Critical Issues in a Global Context

3 credit hours (1 course) selected from approved CLE courses.

Global interdependence is a powerful fact of life as we enter the 21st century. The dilemmas and possibilities humankind faces cannot be effectively addressed by any single culture or group of people acting alone. An awareness of critical issues of the day is thus an essential extension of liberal education and prepares students to respond thoughtfully to the complex world in which they live. As a state institution of higher education, Virginia Tech has a responsibility to prepare students to react creatively and constructively to the social, international, intercultural, and environmental challenges that confront the Commonwealth and the world.

The university requires that undergraduates take at least one course that deals in a substantial way with major issues of critical importance for the larger global society. Courses that satisfy this requirement can be taken in any area of the curriculum, including the major, the Curriculum for Liberal Education, or electives. Students may select from a wide range of courses that focus on major international and intercultural issues in contemporary world affairs, including such areas as politics, the management of con ict, the roles of economic competition and cooperation, demographic issues, and the emerging world order. Many science courses in Area 7 examine global issues associated with environmental decline and restoration. Some engineering courses study the role of technology as a major force in shaping the cultural and economic conditions of human societies. Other courses include comparative or cross-disciplinary examinations of cultures, societies, and belief systems, including those of developing countries. Other courses examine the social and personal implications of cultural, racial, and gender-based differences. Whatever the topical focus of the course, all Area 7 courses utilize interdisciplinary approaches in which a number of relevant factors - historical, ethical, technological, cultural, and/or scientific - are brought to bear on the issues being studied.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Computational Modeling and Data Analytics

Division Leader: M. Embree
Program Manager: C. Conley
Principle Faculty: C. Beattie, J. Chung, M. Chung, E. de Sturler, X. Deng, R. Gramacy, S. Gugercin, A. Habibnia, P. Haskell, R. Hewitt, L. House, L. Johnson, I. Kim, S. Leman, C. Lucero, E. Martin, G. Matthews, C. North, L. Pillonen, M. Pleimling, N. Ramakrishnan, C. Ribbens, S. Sengupta, E. Smith, T. Warburton, J. Wilson, and L. Zeitsman

Web: **www.ais.science.vt.edu/programs/cmda.html**

Overview

The Computational Modeling and Data Analytics (CMDA) program is a joint effort of the departments of Mathematics, Statistics, and Computer Science. It resides in, and is organized as a division of, the College of Science's Academy of Integrated Science. CMDA courses impart the emerging concepts and techniques from mathematics and statistics, with a decidedly computational approach, that are most in demand by a data-driven world. They prepare students as quantitative scientists ready to engage data and modeling problems wherever they may occur. CMDA is Virginia Tech's Big Data degree.

Bachelor of Science in Computational Modeling and Data Analytics

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways to General Education) (see "**Academic Policies**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Computational Modeling and Data Analytics can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Computer Literacy

Most CMDA courses involve the use of statistical and/or mathematical software, primarily (but not limited to) MATLAB, R, C. Java, and Python. Experience with the software is not expected, but students should have familiarity with either the Windows or Macintosh operating system.

Undergraduate Course Descriptions (CMDA)

1984: SPECIAL STUDY
Variable credit course.

2005-2006: INTEGRATED QUANTITATIVE SCIENCES
2005: Integrated topics from quantitative sciences that prepare students for advanced computational modeling and data analytics courses. Topics include: probability and statistics, infinite series, multivariate calculus, linear algebra. 2006: Intermediate linear algebra, regression, differential equations, and model validation. Pre: MATH 1226 for 2005; 2005, MATH 2114 or MATH 2114H, CMDA 2206 for 2006. Co: MATH 2114 for 2005. (6H,6C)

2014: DATA MATTER
This course develops fundamental analytical and programming skills to complete the \034analytic pipeline\035, including specifying research questions, selecting/collecting data ethically and responsibly, processing and summarizing datasets, and stating findings, while considering all assumptions made. Students will identify vulnerabilities in analyses, including sources of bias and ethical implications. Some programming skills recommended, but not required. Some prior use of data recommended, but not required. Pre: MATH 1014. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

2984E: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3605-3606: MATHEMATICAL MODELING: METHODS AND TOOLS
3605: Mathematical modeling with ordinary differential equations and difference equations. Numerical solution and analysis of ordinary differential equations and difference equations. Stochastic modeling, and numerical solution of stochastic differential equations. 3606: Concepts and techniques from numerical linear algebra, including iterative methods for solving linear systems and least squares problems, and numerical approaches for solving eigenvalue problems. Ill-posed inverse problems such as parameter estimation, and numerical methods for computing solutions to inverse problems. Numerical optimization. Emphasis on large-scale problems. Pre: CS 1114 or MATH 3054, MATH 2114 or MATH 2114H or MATH 2405H, MATH 2204 or MATH 2 204H or MATH 2406H or CMDA 2006, MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006 f or 3605; 3605 for 3606. (3H,3C)

3634 (CS 3634): COMPUTER SCIENCE FOUNDATIONS FOR COMPUTATIONAL MODELING & DATA ANALYTICS
Survey of computer science concepts and tools that enable computational science and data analytics. Data structure design and implementation. Analysis of data structure and algorithm performance. Introduction to high-performance computer architectures and parallel computation. Basic operating systems concepts that influence the performance of large-scale computational modeling and data analytics. Software development and software tools for computational modeling. Not for CS major credit. Pre: CS 2114. (3H,3C)

3654 (CS 3654) (STAT 3654): INTRODUCTORY DATA ANALYTICS & VISUALIZATION
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias. Pre: CS 1114 or CS 1044 or CS 1054 or CS 1064, MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005, STAT 3006 or STAT 4705 or STAT 4714 or CMDA 2006. (3H,3C)

4604: INTERMEDIATE TOPICS IN MATHEMATICAL MODELING
Introduction to partial differential equations, including modeling and classification of partial differential equations. Finite difference and finite elements methods for the numerical solution of partial differential equations including function approximation, interpolation, and quadrature. Numerical solution of nonlinear systems of equations. Uncertainty quantification, prediction. Pre: 3606. (3H,3C)

4654 (CS 4654) (STAT 4654): INTERMEDIATE DATA ANALYTICS AND MACHINE LEARNING
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regularization, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks. Pre: (STAT 3654 or CMDA 3654 or CS 3654), (STAT 3104 or STAT 4706 or CMDA 2006). (3H,3C)

4664 (STAT 4664): COMPUTATIONAL INTENSIVE STOCHASTIC MODELING
Stochastic modeling methods with an emphasis in computing are taught. Select concepts from the classical and Bayesian paradigms are explored to provide multiple perspectives for how to learn from complex, datasets. There is particular focus on nested, spatial, and time series models. Pre: (STAT 4106 or CMDA 3605), (CS 1114 or CS 1064 or STAT 2005). (3H,3C)

4864: COMPUTATIONAL MODELING AND DATA ANALYTICS CAPSTONE PROJECT
Capstone research project for Computational Modeling and Data Analytics majors. Cultivates skills including reviewing the literature, creative problem solving, teamwork, critical thinking, and oral, written, and visual communications. Quantitative and computational thinking, informed throughout by ethical reasoning. Pre: 3605, 3634 or CS 3634, CMDA 3654 or CS 3654 or STAT 3654. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Communication

Head: Robert E. Denton, Jr.
Assistant Head: Douglas F. Cannon
Director of Undergraduate Programs: Brandi A. Quesenberry
Director of Graduate Studies: Beth M. Waggenspack
W. Thomas Rice Chair: Robert E. Denton, Jr.
Professors: R. E. Denton Jr., W. W. Hopkins, J. D. Ivory, J. A. Kuypers, and J. C. Tedesco
Professors of Practice: D. F. Cannon, R. J. Reed, and W. B. Roth
Associate Professors: C. Evia, R. L. Holloway, A. H. Ivory, N. J. Logan, J. B. Mackay, M. C. Myers, and B. M. Waggenspack
Assistant Professors: M. A. Duncan, K. Haenschen, M. A. Horning, N. Mielczarek, S. A. Smith, D. J. Tamul, B. A. Watkins, and C. L. Woods
Senior Instructors: E. W. Stallings and B. A. Quesenberry
Advanced Instructors: B. W. Howell, D. M. Jenkins, S. J. Robinson, and H. Shinault
Instructors: C. H. Boor, D. Conner, L. S. Purcell, N. Sowder, S. Stinson, and J. Woolly

Web: **www.liberalarts.vt.edu/departments-and-schools/department-of-communication.html**

Overview

The majors in communication, leading to a B.A., allow students to develop a broad understanding of the discipline and specific expertise in Communication Studies, Multimedia Journalism, Public Relations, or Sports Media and Analytics. The Department of Communication focuses on strategic, theoretical, and practical application of message creation, delivery, analysis, and criticism in cultural and historical contexts.

Students in communication majors are prepared to continue their studies in graduate school or immediately apply their skills in various professional settings because of the broad applicability of both the theory to which they are exposed and the competencies they develop. Rooted in a strong liberal arts curriculum, these majors prepare students to enter careers in mass media, business, public service, government, or professional specializations, such as law.

Majors

Students choose one of four majors in communication to specialize in the discipline: Communication Studies, Multimedia Journalism, Public Relations, and Sports Media and Analytics.

Communication Studies (CMST) - This major develops human-interaction strategies and skills for face-to-face, public, and organizational contexts relating to decision making, influence, and information exchange. As a graduate, you might consider careers in business, health, civic engagement, public opinion, law, education, and ministry.

Public Relations (PR) - This major emphasizes both skill and management functions of public relations through theoretical and practical applications. Public relations spans media, organizational, corporate, and political contexts and includes investigation and analysis of public relations situations (e.g., crises, successes), message production and campaign planning, writing and presentation, and evaluation of public relations strategies. Public relations permeates many areas of corporate, non-profit, and political work, so this major provides students a foundation for many different career paths. The public relations curriculum is certified by the Public Relations Society of America.

Multimedia Journalism (MJ) - This major prepares students for news careers at newspapers, magazines, broadcast and cable outlets, and new media operations. The lines that separate these specialties are blurring as media convergence becomes the norm. Courses provide both practical skills and theory as they address history, law and ethics, current controversies and opportunities in the changing news media.

Sports Media and Analytics - This major prepares students to produce and deliver sports news, consider ways to promote the sports industry, and analyze data related to sports accomplishments, fan participation, and social media. Employment opportunities are varied and include sports reporting; public relations for sports venues, teams, or athletes; and promotional work for businesses that support the fans.

Major Requirements

The curriculum is designed to provide foundational and development courses along with major-specific study. Students are introduced to concepts early in the undergraduate career, and the curriculum allows them to build knowledge and skills as they work on increasingly complex tasks. Students develop skills in written, spoken, and visual communication across their studies in each major. At the foundational level, students in every major are required to take the same introductory courses.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When you consider information about the degree requirements, always choose the year of your expected graduation. Requirements for graduation are listed on checksheets. The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar's website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor Requirements

The department offers a minor in strategic communication. This multidisciplinary minor is open to majors from across the university and is especially appropriate for students in business or science, technology, engineering, and mathematics disciplines. Coursework allows students to learn how strategic communication works in a variety of industries and prepare for the 21st century workforce. Few jobs have no communication components.

The minor curriculum introduces students to strategic communication through a four-course introductory experience. It covers basic communication skills, public relations, design, and accounting. Introductory coursework requires students to integrate multiple areas of learning such as discourse, quantitative and computational thinking, reasoning in the social sciences, critique and practice in design and the arts, international and cultural awareness, and understanding ethical issues. Two advanced courses enable students to focus on particular issues in strategic communication, such as issues management, corporate social responsibility, or communication law. A capstone course lets students synthesize and analyze topics and issues they explored in the four foundational and two advanced courses.

Specific course requirements for the 18-hour strategic communication minor are explained on a checksheet.

The department organizes courses that fulfill major and minor requirements into four disciplinary areas: Communication Studies (CMST), Communication (COMM), Journalism and Mass Communication (JMC), and Public Relations (PR).

Satisfactory Progress Toward the Degree

University policy requires that students demonstrate their progress toward the degree by meeting minimum requirements. A student will be certified as making satisfactory progress toward a degree by meeting the following requirements:

- Completion of COMM 1014 within the first six classes (18 hours) in the major
- Completion of COMM 2124 within the first eight classes (24 hours) in the major
- Overall GPA: 2.0
- COMM GPA: 2.0

Students who fall below the standard for either the overall GPA or the COMM GPA will have one semester to regain the required GPA standards. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in any communication major.

Freshmen and External Transfers into Communication

Incoming freshmen and students enrolled at other institutions should follow directions for application as shown on the Admissions website.

Internal Transfers into Communication

Students enrolled in other Virginia Tech majors who wish to transfer into Communication may use the online system for application.

Departmental Website and Contact

Please see the Departmental Website for more information about majors and the minor:
www.liberalarts.vt.edu/departments-and-schools/department-of-communication.html
Contact: comm@vt.edu

Undergraduate Course Descriptions (CMST)

2064: THE RHETORICAL TRADITION
Analysis of great classic and contemporary theories of rhetoric developed throughout the world during the past 2500 years to demonstrate the dynamic, critical nature of persuasive communication. Study of methodological approaches to rhetorical criticism, ethics of message creation, communication contexts, emerging perspectives, and impact of changing culture on rhetorical theory. (3H,3C)

2134: INTRODUCTION TO HEALTH COMMUNICATION
Introduction to health communication with a focus on current issues and perspectives, including patient-provider communication, cultural conceptions of health and illness, media portrayals of health, communication in health organizations, health communication theories, information technologies in health communication, ethical considerations, and health promotion campaigns. (3H,3C)

3044: ORAL COMMUNICATION CENTER PRACTICUM
Focus on peer pedagogy in a communication center to support development of oral communication competence among students across disciplines. Emphasis on oral communication theory applied to one-on-one support for students' oral presentations. May repeat 1 time. Pre: COMM 1016 or COMM 2004. (1H,1C)

3064: PERSUASION
Theoretical foundations of persuasion; techniques of persuasion; contemporary persuasive practice and campaigns; persuasive media strategies. Junior standing required. Pre: COMM 1014. (3H,3C)

3074: PERSUASIVE PUBLIC SPEAKING
Advanced critical analysis, preparation and presentation of persuasive speeches. Study of advanced rhetorical principles with emphasis on policy speeches and the use of proofs to convince, strengthen beliefs, and motivate listeners to overt action. Advanced focus on approaches to research, audience analysis, effective organization and extemporaneous delivery. Pre: COMM 1016 or COMM 2004. (3H,3C)

3124: INTERPERSONAL COMMUNICATION

Basic theories and processes of person-to-person communication; interpersonal perception; verbal and nonverbal communication; establishment of relationships in the family and work situation. Junior standing required. (3H,3C)

3134: PUBLIC ADVOCACY
Practical reasoning and argumentation about questions of community significance, emphasizing critical thought, rhetorical strategies, and advocacy. Junior standing required. Pre: COMM 2004 or COMM 1016. (3H,3C)

3164: GROUP PROCESSES AND PRESENTATIONS
Study of group theory and its application to a group project, including team dynamics and leadership, conflict resolution, project management, and team presentation strategies. (1H,1C)

3214: PROFESSIONAL COMMUNICATION
Theory and contemporary practice of professional oral communication, including interpersonal interaction, small group problem-solving, and public presentations. Emphasis on ethical exchanges in traditional or virtual workshops settings. Pre: COMM 1016 or COMM 2004. (3H,3C)

3264: COMMUNICATION AND GENDER
Examines how verbal, nonverbal, and visual communication create, sustain, and challenge the meaning of gender and cultural structures and practices. Junior standing. (3H,3C)

3274: SOCIAL DIMENSIONS OF GAMES, SIMULATIONS, AND VIRTUAL ENVIRONMENTS
Social impacts, key issues, and research findings related to video games, simulations, and virtual environments. Ethical, policy, and social dimensions in society; industry data and research. Prerequisite: Junior standing. (3H,3C)

4174: DIGITAL ADVOCACY CAMPAIGNS
Study of advocacy campaigns with digital components. Rhetorical considerations in message construction, analysis of persuasive techniques, ethical standards, and strategies for campaign development. Senior standing required. Pre: (COMM 1016 or COMM 2004), COMM 2124. (3H,3C)

4224: TOPICS IN MEDIA CRITICISM
Selected topics in media criticism. Offered on demand. Senior standing and consent required. (3H,3C)

4244: TOPICS IN COMMUNICATION SCIENCE AND SOCIAL INQUIRY
Selected topics in communication science and social inquiry. Emphasis on application of theory and research in selected context. May include theories of persuasion and social influence or media studies. Theoretical foundations, research methods, media and technology that determine the communication effects, strategies, and tactics used to reach and influence publics. May be repeated with different content for a maximum of 9 credit hours. Pre: Junior standing. Pre: COMM 1014. (3H,3C)

4324: ISSUES IN HEALTH COMMUNICATION
Study of issues related to the theory and practice of health communication, including interpersonal, public, organizational, political, and cultural. Junior standing required. (3H,3C)

Undergraduate Course Descriptions (COMM)

1004: FIRST-SEMESTER EXPERIENCE IN COMMUNICATION
Introduction to areas of research, ethical behaviors, and career paths in the discipline. Consideration of strategies for learning, accessing advising, and locating resources. (1H,1C)

1014: INTRODUCTION TO COMMUNICATION
Survey of the communication discipline across areas of specialization from interpersonal to mediated and mass communication, including history and fundamental concepts, theories, contexts. Emphasis on ethical human behavior and message analysis. (3H,3C)

1015-1016: COMMUNICATION SKILLS

Introduction to oral and written communication. 1015: Focus on oral and written communication in interpersonal, small group, and public contexts. Special emphasis on the writing process, listening, interviewing, conflict resolution, critical analysis, and communication in digital and visual media. 1016: Continued Study in oral and written communication skills for small group and public contexts. Focus on practical applications in ethical research and information gathering, audience analysis and adaptation, message development, and oral, written, and visual presentations by individuals and groups. May not receive credit for both 1016 and 2004. (3H,3C)

2004: PUBLIC SPEAKING
Strategies and practice for speaking to specific audiences. Ethical considerations for message preparation, development, presentation, and evaluation. Pre: Sophomore standing. COMM 2004 partially duplicates COMM 1016. (3H,3C)

2014: SPEECH COMMUNICATION
Introductory study of communication messages across various types, including intrapersonal, interpersonal, small group and public. Credit may not be earned for both 1015 and 2014. (3H,3C)

2024: MEDIA WRITING
Writing and information gathering skills including news, features, press releases, and advertising copy for broadcast, print and public relations media. Sophomore Standing Required. Pre: 1016 or ENGL 1106 or ENGL 1204H. (3H,3C)

2034: VISUAL MEDIA
An introduction to the visual image and visual thinking applied to photography, video, and film. Sophomore standing required. Pre: 1016 or ENGL 1106 or ENGL 1204H. (3H,3C)

2084: MEDIA AND SOCIETY
An examination of media influence on society. Emphasis on impact of media (such as newspapers, film, social networks, and video games) on diverse audiences and cultures. Considerations of the evolution of media; social institutions and trends related to the media; domestic, global, ethical, and legal questions posed by the media; intercultural communication; and new technology’s influence on society. (3H,3C)

2094: COMMUNICATION AND ISSUES OF DIVERSITY
Study of communication theory and practice related to diversity and the media. Analysis of ethical implications of media influences on workplace communication across disciplines. Development of a personal understanding of diversity and identity by examining media producers, audiences, workforces, outlets, and content. Pre: 1016 or ENGL 1106 Pre: 1016 or ENGL 1106. (3H,3C)

2124: INTRODUCTION TO COMMUNICATION RESEARCH
Study of approaches to research in the discipline, including identification and analysis of existing research; procedures for conducting and reporting basic research in communication. Sophomore Standing required. Pre: 1016 or ENGL 1106 or ENGL 1204H. (3H,3C)

2754H: TOPICS IN SINGLE MEDIUM COMMUNICATION ABOUT TECHNOLOGY INNOVATION
Study of discovery, analysis, creation, and evaluation of single medium - written or spoken or visual - presentations of ideas related to collaborative technology innovation for societal impact. Analysis of how race, class, gender, and age shape written, oral, or visual expression in the United States and vice versa. Special attention to single medium communications with stakeholders in business, government agencies, nonprofit organizations, and universities. Ethical dimensions of written, spoken, or visual communication about collaborative technology innovation for societal impact. May be repeated 2 times with different content for a maximum of 3 credits. Pre: 1016 or ENGL 1105. (1H,1C)

2764H: TOPICS IN MULTIMEDIA COMMUNICATION ABOUT TECHNOLOGY INNOVATION
Study of the discovery, analysis, creation, and evaluation of multimedia presentation of ideas related to collaborative technology innovation for societal impact. Analysis of how race, class, gender, and age shape multimedia expression and vice versa. Special attention to communicating across disciplinary, organizational, and cultural differences in the workplace. Ethical dimensions of multimedia communication about collaborative technology innovation for societal impact. May be repeated 2 times with different content for a maximum of 3

credits. Pre: 2754H. (1H,1C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3024: DIGITAL PUBLISHING
Study and contemporary practices in digital publishing aimed at multichannel distribution for diverse audiences. Principles, standards, workflows, technologies, and strategies for ethical and accessible design and automation of content for Web, mobile, print, multimedia, and voice environments. Pre: 2034. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4024: COMMUNICATION LAW
Study freedom of speech and the press and how these freedoms apply to the press, public relations, advertising and personal speech. Consideration of First Amendment theories and jurisprudence; related ethical issues. Senior standing. (3H,3C)

4204: COMMUNICATION INTERNSHIP
Placement in a communication industry for practical internship under supervision by a departmental advisor and a professional in the field. May be repeated for credit up to a maximum of 6 hours credit. Junior standing and consent required. Pass/Fail only. Variable credit course.

4404: COMMUNICATION CAPSTONE
In-depth study of a particular issue or theme in communication. Integrates previous work in the discipline, focuses on research and presentation of research. Pre: Junior standing. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (JMC)

1114: INTRODUCTION TO MEDIA PRODUCTION TECHNOLOGY
Introduction to basic technologies necessary for multimedia production. Attention to aesthetics and technical aspects of production technologies, including creation, editing, and organization of content. (3H,3C)

2074: INTRODUCTION TO SPORTS MEDIA
Development, concepts, and impact of sports media, including roles and responsibilities of journalists, production staff, and public relations professionals. Considerations of stakeholders' behaviors and connections. Study of ethical standards and perspectives, communication in sports organizations, types of media, issues in context, and data analytics. (3H,3C)

3114: VIDEO PRODUCTION: STUDIO
Producing, directing, and writing live video segments; operating control room and studio equipment including studio camera, video switcher, audio board and the creation of video graphics and written packages. Pre: COMM 2034. (2H,3L,3C)

3154: MULTIMEDIA REPORTING
Multimedia news gathering, news writing, audio/visual storytelling, and news judgment for the print and online media. Consideration of professional strategies and standards for reporters, including legal and ethical issues. Pre: COMM 2024, COMM 2034. (3H,3C)

3174: ADVANCED MULTIMEDIA REPORTING
Multimedia gathering and writing of complex news, features, and documentary; visual content and news judgment for television, print and online media; techniques of broadcast interviewing and on-camera performance. Considerations of legal and ethical issues related to the reporting of complex news. Pre: COMM 3154 or JMC 3154. (2H,2L,3C)

3244 (PSCI 3244): POLITICAL COMMUNICATION
Distribution of political information; elite-mass communication; alternative models of political communication; communication and telecommunications policy. Pre: PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024. (3H,3C)

3254 (PSCI 3254): MEDIA AND POLITICS
Explores the role of the mass media in contemporary American politics by examining the development of media as sources of social and political influence. Study of news organizations, their coverage of electoral and issue campaigns, and their impact on candidates and voters. Includes the role of new technologies in campaigns. Pre: Junior Standing. (3H,3C)

3304: TOPICS IN SPORTS COMMUNICATION
Study of the theory and practices related to sports communication in fields such as public relations or reporting. Topics may include print, broadcast, and online news; college sports information; social media; crisis management; and media relations. May be repeated once with different course content. Junior standing. (3H,3C)

3314: SPORTS JOURNALISM
Theory and practice of sports journalism, including strategies for writing and broadcasting sports information. Study of ethics and professional standards. Junior standing required. Pre: COMM 2024, COMM 2034. (3H,3C)

4014: MEDIA EFFECTS
Impact of mass media on individuals and on society; methods for documentation of media effects; research about effects on various demographic groups such as children, elderly, and minorities; effects of advertising; effects of interactive and time shift technologies. Junior standing required. Pre: COMM 2124. (3H,3C)

4044 (IS 4044): INTERNATIONAL COMMUNICATION
Comparative perspectives on global communication systems; problems with the flow of information; roles of international organizations; mass communication and national development; implications for conflict resolution; selected case studies. Senior standing required. (3H,3C)

4064: SOCIAL MEDIA ANALYTICS
Introduction to analytic techniques for social media platforms. Quantitative and qualitative analytic techniques.

Design, implementation, and analysis of experimental and observational studies of how people use and engage with social media platforms and how platforms themselves can be used to drive engagement with content. History and trending topics in social media use. Ethical issues involving social media and big data. Pre: COMM 2124. (3H,3C)

4094: BROADCAST MANAGEMENT
Broadcast management procedures; programming; sales and advertising. Senior standing required. Pre: COMM 3154 or JMC 3154. (3H,3C)

4114: PHOTOJOURNALISM
Interpretive and creative photography applied to journalism; cameras, films, photography techniques; history of photography as communication; advanced darkroom techniques. Junior standing required. Pre: COMM 2034, COMM 2024. (3H,3C)

4134: EDITORIAL WRITING
Development and function of the editorial page; writing of editorials, reviews, and personal columns; examination of role of letters and syndicated columns and cartoons; problems editorial writers face in their jobs and communities. Junior standing required. (3H,3C)

4144: MAGAZINE WRITING
The writing of feature material (as opposed to the reporting of hard news), plus detailed examination of several article types from a wide variety of contemporary magazines and newspapers. Junior standing required. (3H,3C)

4154: DIGITAL NEWSROOM
Production of news, including newsroom operations, management, legal and ethical issues, and professionalism. Professional reporting in the newsroom setting and across platforms, including professional writing, interviewing, and photography/videography. Pre: COMM 3174 or JMC 3174. (1H,3L,3C)

4254: TOPICS MULTIMEDIA JOURNALISM
Selected topics in multimedia journalism; emphasis on critical analysis of issues in journalism, and application of media to disseminate information. May be repeated for credit up to a maximum of 6 credit hours with different content. Pre: COMM 2024, COMM 2034. (3H,3C)

4264: SOCIAL MEDIA THEORY AND PRACTICE
Study of social media as a professional communication and media tool. Emphasis on foundations in communication theory and contemporary approaches. (3H,3C)

4274: BROADCASTING PERFORMANCE
Advanced study of on-air performance for broadcasters. Professional behaviors and strategies for developing conversational writing, broadcast style, interviewing, reporting, and anchoring. Pre: COMM 3154 or JMC 3154. (3H,3C)

4334: COMMUNICATION ETHICS
Discussion of issues related to professional communication ethics; emphasis on recognizing ethical issues, applying theoretical models and critical thinking skills to ethical issues in multimedia journalism, public relations, and communication studies. Includes research on topics related to communication ethics. Pre: Junior standing. (3H,3C)

4344: FREE SPEECH IN CYBERSPACE
Discussion of free expression on the Internet; an examination of how First Amendment law; state laws and federal communication policies impact the multiple kinds of speech that take place in cyberspace; examination of the history and development of the Internet and the future of free speech in cyberspace. Pre: Senior standing. (3H,3C)

4344H: FREE SPEECH IN CYBERSPACE
Discussion of free expression on the Internet; an examination of how First Amendment law; state laws and federal communication policies impact the multiple kinds of speech that take place in cyberspace; examination of the history and development of the Internet and the future of free speech in cyberspace. Pre: Senior

standing. (3H,3C)

4374: NEW COMMUNICATIONS TECHNOLOGY
Identify recent trends in the innovation of new communications technologies; storage, transmission, and display systems of mediated communication: optical disc, common carriers, telecommunication-computer linkages, high-definition TV, and virtual reality; information industries and society; markets for new and existing telecommunication services. Junior standing required. Pre: COMM 2084 or COMM 4014 or JMC 4014. (3H,3C)

Undergraduate Course Descriptions (PR)

2044: PRINCIPLES OF PUBLIC RELATIONS
Principles of public relations practice; public relations in organizations; responsibilities of the public relations practitioner; legal and ethical considerations; role of public relations in society; history of the field and key people who influenced its development; choosing appropriate communication channels/media. (3H,3C)

3014: PUBLIC RELATIONS CASES
Analysis of contemporary and historic public relations cases. Emphasis on theories, research techniques, planning methods, implementation strategies, evaluation standards, and ethical considerations in public relations programs and campaigns. Pre: COMM 2044 or PR 2044. (3H,3C)

3084: ADVANCED PUBLIC RELATIONS RESEARCH METHODS
Analysis and implementation of contemporary academic and professional research tools for public relations. Emphasis on development of research designs, assessment and evaluation of public relations programs and campaigns, and implementation of ethical research practices and standards. Pre: (COMM 2044 or PR 2044), COMM 2124. (3H,3C)

3144: WRITING AND EDITING FOR PUBLIC RELATIONS
Advanced writing and editing used to structure and present information in the practice of public relations. Includes message development, message design for delivery through various media, copyediting skills and tools, and strategies for dissemination. Pre: COMM 2024. (3H,3C)

3324: CORPORATE COMMUNICATION
Examines communication theories, strategies and tactics that corporations use in their public relations efforts to reach and influence publics. Prepares students for "in-house" public relations work and familiarizes them with expectations of corporate clients. Introduces students to the important role communication plays within and between for-profit, nonprofit, and government institutions. Emphasis on the influence of corporate culture, ethics and values on communication styles. Junior standing required. (3H,3C)

3334: PUBLIC RELATIONS AND CORPORATE SOCIAL RESPONSIBILITY
Explores role of communication in corporate social responsibility. Emphasis on the ethical implications of communicating the need to generate profits with the need to ensure that corporate actions do not harm important stakeholders such as employees, investors, customers, and communities. Pre: COMM 2044 or PR 2044. (3H,3C)

3344: PUBLIC RELATIONS AND SPORTS
Examines communication theories, strategies, and tactics that sports organizations use in their public relations efforts. Introduces students to the dynamic relationship between sports organizations, media, and fans. Study of ethics and professional standards in sports public relations. Emphasizes the role of public relations in sports as a strategic communication and management function. (3H,3C)

4074: ORGANIZATIONAL COMMUNICATION
Role of communication in complex organizations; communication networks, communication and management, message systems, decision-making; relationships between organizational theory and communication. Senior standing required. (3H,3C)

4164: PUBLIC RELATIONS ADMINISTRATION
Public Relations (PR) administration issues related to budgeting, strategy, legal issues, and campaigns in an

organization. Emphasis on PR theory and ethics. Pre: COMM 2044 or PR 2044. (3H,3C)

4304: PUBLIC RELATIONS CAMPAIGNS
Public relations campaign research, planning, implementation and evaluation. Emphasis on applying theory in campaign contexts; executing applied research; setting objectives; developing strategic plans, messages and budgets; carrying out courses of action; and evaluating results. Pre: COMM 2124, (COMM 3144 or PR 3144), (COMM 3014 or PR 3014). (3H,3C)

4364: ISSUE MANAGEMENT IN PUBLIC RELATIONS
Principles of issue management: creation, development, and resolution; role of rhetoric in public policy processes; legal constraints; strategies; social responsibility. Junior standing required. (3H,3C)

4414: PUBLIC RELATIONS STANDARDS AND PRACTICES
Addresses complexities of public relations research, planning, implementation, and evaluation required for professional certification. Includes special emphasis on public relations legal and ethical practices. Senior standing. Pre: COMM 2044 or PR 2044. (3H,3C)

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Computer Science

Head: Calvin J Ribbens
Thomas L. Phillips Professor: N. Ramakrishnan
Elizabeth and James Turner Jr. '56 Professor: W. Feng
Professors: O. Balci, C. L. Barrett[1], D. Bowman, A. Butt, K. W. Cameron, I. R. Chen, S. H. Edwards, E. A. Fox, L. S. Heath, D. G. Kafura, B. Knapp[2], W. Lou, C. T. Lu, M. Marathe[1], T. M. Murali, C. L. North, A. Onufriey, A. Sandu, C. A. Shaffer, D. G. Tatar, and L. T. Watson
Associate Professors: G. Back, Y. Cao, D. Gracanin, A. Kelliher[2], D. S. McCrickard, C. Reddy, E. Tilevich, A. Vullikanti[1], D. Yao, and L. Zhang
Assistant Professors: M. Hicks, B. Huang, X. Jian, C. Jung, D. Lee, K. Luther, N. Meng, T. Mitra, B. A. Prakash, S. Raghvendra, F. Servant, and G. Wang
Associate Professor of Practice: S. Harrison
Assistant Professor of Practice: M. Ellis and G. Kulczycki
Senior Instructors: N. D. Barnette and W. McQuain
Professor Emeritus: D. C. S. Allison, J. D. Arthur, R. W. Ehrich, J. A. N. Lee, H. R. Hartson, R. E. Nance, and B. Ryder

[1] Joint appointment with Biocomplexity Institute
[2] Joint appointment with Institute for Creativity, Arts, and Technology

Web: **www.cs.vt.edu**
E-mail: **csundg@cs.vt.edu**

The Field of Computer Science

In a contemporary world where every educated person must have some knowledge of computing, the Department of Computer Science offers courses to meet a variety of needs. The department offers a bachelor of science program to prepare specialists in the area of computer science itself, a minor in computer science, and individual courses directed to the needs of non-majors who will be using computers as tools in their chosen careers. The department also offers the M.S. and Ph.D. in computer science (see **Graduate Catalog**).

As a major, computer science involves far more than just writing computer programs. It is a technically rigorous field that requires a strong background in mathematics. Computer scientists must be good at problem solving. Their work requires the ability to think abstractly and to represent real-world objects and interactions as symbols that can be manipulated by a computer. The field of computer science is characterized by rapid change and entrepreneurship, with new opportunities emerging every year to improve life in diverse areas such as education, communication, science, commerce and entertainment.

Accreditation and Program Objectives

The Bachelor of Science degree in Computer Science is accredited by the Computing Accreditation Commission of ABET, **www.abet.org**.

Part of the accreditation process is a clear statement of program objectives and desired outcomes for graduates. The objective of the computer science program is to provide majors with a balanced breadth and depth of knowledge in computer science that allows them the choice between continuing their education in graduate school and beginning their professional career, and to excel in either environment.

The following program educational objectives describe what graduates of the Virginia Tech Computer Science program are expected to attain within a few years of graduation. Alumni will have:

- Demonstrated technical expertise by applying computer science knowledge and practice to solve challenging problems, whether in employment, graduate study, or individual pursuits;
- Advanced their skills in communication, teamwork, and professional and ethical behavior;
- Demonstrated leadership in their technical or professional pursuits;
- Engaged in post-graduate learning through graduate studies, professional improvement opportunities, or self-study;
- Served society through professional or personal contribution.

Desired outcomes for graduates are organized into the following six areas:

- Foundations of computing: ability to apply knowledge of mathematics and science to carry out analysis of computer science problems and design appropriate solutions; ability to use techniques, skills, and modern software development tools necessary for computing practice.
- Depth of knowledge: ability to identify, formulate, and solve computer science problems; ability to design a computing system to meet desired needs; ability to apply problem-solving strategies to new, unknown, or open-ended situations in computer science.
- Breadth of knowledge: knowledge and understanding of the impact of the many sub-disciplines of computer science.
- Communication skills: ability to function in teams; ability to use written and oral communication skills effectively.
- Professional ethics: understanding of professional and ethical responsibility.
- Lifelong learning: recognition of the need for and ability to engage in lifelong learning; ability to

acquire and use the ever-changing technical knowledge required of computing professionals.

Program Requirements

The curriculum in computer science is designed to provide a broad general computer science background that will prepare a student for a professional career as a computer scientist or to continue study at the graduate level. All majors take a set of foundational courses in software design and development, algorithms, and computer organization at the freshmen and sophomore level. Students at the junior and senior level select one theoretical course, four specialty courses and a capstone course according to their individual interests within the field.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Opportunities for Majors

The curriculum in computer science is designed to provide a broad general computer science background that will prepare a student for a professional career as a computer scientist or to continue study at the graduate level. All majors take a set of foundational courses in software design and development, algorithms, and computer organization at the freshman and sophomore level. Students at the junior and senior level select one theoretical course, four specialty courses and a capstone course according to their individual interests within the field. In all, a minimum of 44 credit hours of computer science is required.

The department offers computer science majors the opportunity to enhance their education through a variety of curricular and extracurricular activities. Students who meet the requirements for independent study or undergraduate research can pursue research or individualized study under the direction of a faculty member. Through the honors program, superior students can work toward earning their degree "in honors" or even elect to earn both the bachelor's and master's degrees in an accelerated undergraduate/graduate program. The Cooperative Education Program makes it possible for students to acquire professional experience while pursuing their degree.

The department sponsors chapters of three national computer science organizations: the Association for Computing Machinery (ACM), the national professional organization for computer scientists; the Association for Women in Computing (AWC), which is dedicated to the advancement of women in information technology fields; and Upsilon Pi Epsilon (UPE), the national computer science honor society. Additional recognition of student achievements is made during the annual graduation ceremonies. Among the awards given are the Gorsline award, awarded to a rising senior who has overcome freshman-year academic difficulties and subsequently demonstrated great academic achievement.

Information for Non-Majors

The department offers a Computer Science minor for non-majors seeking a strong background in computer science. The requirements to earn a minor in Computer Science can be found on its checksheet by visiting the University Registrar website at

www.registrar.vt.edu/graduation/checksheets/index.html. Minors must meet the same prerequisites as majors. This includes Math 2534 as a co-requisite for CS 2505 and achievement of a "C" (2.0) or better in all CS courses which are prerequisites for subsequent CS courses.

Computational Facilities

The Department of Computer Science possesses extensive facilities for both instruction and research. There are several undergraduate teaching laboratories and a number of specially equipped research laboratories. These include two large parallel computing clusters and numerous compute and file servers for research and instruction in areas such as animation, digital libraries, software engineering, data mining, bioinformatics and networking. The department also operates extensively equipped laboratories for human-computer Interaction, virtual environments and information visualization. These labs include display walls, state-of-the-art 3D and head-mounted displays, and a 4-wall CAVE immersive theater.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Curriculum for Liberal Education (see Academics) and toward the degree in computer science.

Satisfactory progress toward the B.S. in Computer Science requires that a Computer Science major must:

- be registered in at least one 3-credit course required in the major during each on-campus semester of the regular academic year;
- maintain a GPA of 2.0 or better in the major;
- not take any CS course required in the major more than twice, including attempts ending in course withdrawal; and
- not repeat more than 3 CS courses required in the major, including attempts ending in course withdrawal.

Undergraduate Course Descriptions (CS)

1014: INTRODUCTION TO COMPUTATIONAL THINKING
An exploration of basic ideas of computational thinking focusing on the perspectives, thought processes, and skills that underlie computational approaches to problem formulation and problem solving. Applications of computational tools to investigate complex, large-scale problems in a variety of knowledge domains. Basic introduction to algorithms and a practical programming language. Examination of the societal and ethical implications of computational systems. (3H,3C)

1044: INTRODUCTION TO PROGRAMMING IN C
Fundamental concepts underlying software solutions of many problems. Structured data, statement sequencing, logic control, input/output, and functions. The course will be taught using a structured approach to programming. Partially duplicates 1344. (3H,3C)

1054: INTRODUCTION TO PROGRAMMING IN JAVA
This course provides an introduction to object oriented programming using the Java language. Fundamental concepts underlying programming and software solutions to many problems. Structured data, statement sequencing, logic control, classes, objects, methods, instantiation of classes, sending messages to objects. (2H,2L,3C)

1064: INTRODUCTION TO PROGRAMMING IN PYTHON
Developing computational problem solving skills and software solutions to a variety of multimedia, scientific, and engineering problems using the Python programming language. Statement sequencing, conditional program flow, iteration, functional decomposition, and recursion. Simple numeric data types, strings, lists, list comprehensions, sets, and dictionaries. Input/output of file-based data, content obtained from the web, and manipulation of digital images. Basic object-oriented concepts, classes, objects, and

methods. (3H,3C)

1114: INTRODUCTION TO SOFTWARE DESIGN
Fundamental concepts of programming from an object-oriented perspective. Basic software engineering principles and programming skills in a programming language that supports the object-oriented paradigm. Simple data types, control structures, array and string data structures, basic algorithms, testing and debugging. A basic model of the computer as an abstract machine. Modeling and problem-solving skills applicable to programming at this level. Partially duplicates 1054, 1124, and 1705. (2H,2L,3C)

1124: INTRODUCTION TO MEDIA COMPUTATION
This course teaches fundamental manipulations of digital media as an introduction to computer science. Basic software engineering principles and programming skills are taught with a programming language that supports object-oriented programming. Simple data types, control structures, array and string data structures and algorithms, testing and debugging. Partially duplicates 1054 and 1705. (2H,2L,3C)

1604: INTRODUCTION TO THE INTERNET
Introduces the concepts, software, data organization and issues involved with using networked information. Also covers file formats (as applied in networked hypermedia and multimedia sound/video documents), local and global (Internet) network access, electronic mail, transferring files, network news, the World Wide Web, digital libraries, on-line public access catalogs and electronic journals, CD-ROMs and on-line databases, and commercial and other networks. Word processing ability required. (1H,1C)

1944: COMPUTER SCIENCE FIRST YEAR SEMINAR
An introduction to academic and career planning for computer science majors. Pass/Fail only. Pre: 1114. (1H,1C)

2104: INTRODUCTION TO PROBLEM SOLVING IN COMPUTER SCIENCE
This course introduces the student to a broad range of heuristics for solving problems in a range of settings that are relevant to computation. Emphasis on problem-solving techniques that aid programmers and computer scientists. Heuristics for solving problems "in the small" (classical math and word problems), generating potential solutions to "real-life" problems encountered in the profession, problem solving through computation, and problem solving in teams. Pre: MATH 1205 or MATH 1225 or MATH 1526, CS 1114. (3H,3C)

2114: SOFTWARE DESIGN AND DATA STRUCTURES
A programming-intensive exploration of software design concepts and implementation techniques. Builds on knowledge of fundamental object-oriented programming. Advanced object-oriented software design, algorithm development and analysis, and classic data structures. Includes a team-based, semester-long software project. A grade of C or better is required in CS pre-requisite 1114 or 1124. Pre: 1114 or 1124. (2H,2L,3C)

2164 (BIT 2164) (PSCI 2164): FOUNDATIONS OF CONTEMPORARY SECURITY ENVIRONMENTS
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats. (3H,3C)

2304: SELF STUDY IN A PROGRAMMING SYSTEM
Guided self-study in a specific programming system, its syntax and applications; based on prior knowledge of the programming process and experience in programming with some high level language; may be taken three times for credit with different system each time; may be taken only twice for CS major or minor credit; systems to be offered may include FORTRAN, COBOL, C, UNIX, LISP. A grade of C or better required in CS prerequisite 1706. Pre: 2114. (1C)

2505-2506: INTRODUCTION TO COMPUTER ORGANIZATION
An introduction to the design and operation of digital computers. Works up from the logic gate level to

combinational and sequential circuits, information representation, computer arithmetic, arithmetic/logic units, control unit design, basic computer organization, relationships between high level programming languages and instruction set architectures. A grade of C or better is required in CS prerequisite. Corequisites: MATH 2534 or MATH 3034. Pre: 2114 for 2505; 2505, 2114, (MATH 2534 or MATH 3034) for 2506. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3114: DATA STRUCTURES AND ALGORITHMS
Advanced data structures and analysis of data structure and algorithm performance. Sorting, searching, hashing, and advanced tree structures and algorithms. File system organization and access methods. Course projects require advanced problem-solving, design, and implementation skills. A grade of C or better is required in CS prerequisites 2114 and 2505. Pre: 2114, 2505, (MATH 2534 or MATH 3034). (3H,3C)

3214: COMPUTER SYSTEMS
Introduction to computer systems as they are relevant to application programmers today, with emphasis on operating system principles. Operating system design and architectures; processes; threads, synchronization techniques, deadlock; CPU scheduling; system call interfaces, system level I/O and file management; shell programming; separate compilation, loading and linking; inter-process communication (IPC); virtual and physical memory management and garbage collection; network protocols and programming; virtualization; performance analysis and optimization. A grade of C or better is required in CS pre-requisites 2506 and 2114. Pre: 2506, 2114. (3H,3C)

3304: COMPARATIVE LANGUAGES
This course in programming language constructs emphasizes the run-time behavior of programs. The languages are studied from two points of view: (1) the fundamental elements of languages and their inclusion in commercially available systems; and (2) the differences between implementations of common elements in languages. A grade of C or better required in CS prerequisite 3114. Pre: 3114. (3H,3C)

3414 (MATH 3414): NUMERICAL METHODS
Computational methods for numerical solution of non-linear equations, differential equations, approximations, iterations, methods of least squares, and other topics. A grade of C or better required in CS prerequisite 1044 or 1705. A student can earn credit for at most one of 3414 and MATH 4404. Pre: (1044 or 1705 or 1114 or 1124), (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

3604: PROFESSIONALISM IN COMPUTING
Studies the ethical, social, and professional concerns of the computer science field. Covers the social impact of the computer, implications and effects of computers on society, and the responsibilities of computer professionals in directing the emerging technology. The topics are studied through case studies of reliable, risk-free technologies, and systems that provide user friendly processes. Specific studies are augmented by an overview of the history of computing, interaction with industrial partners and computing professionals, and attention to the legal and ethical responsibilities of professionals. This is a web-supported course, incorporating writing intensive exercises, making extensive use of active learning technologies. A grade of C or better required in CS prerequisite 3114. Pre: 1944, 2114, COMM 2004. (3H,3C)

3634 (CMDA 3634): COMPUTER SCIENCE FOUNDATIONS FOR COMPUTATIONAL MODELING & DATA ANALYTICS
Survey of computer science concepts and tools that enable computational science and data analytics.

Data structure design and implementation. Analysis of data structure and algorithm performance. Introduction to high-performance computer architectures and parallel computation. Basic operating systems concepts that influence the performance of large-scale computational modeling and data analytics. Software development and software tools for computational modeling. Not for CS major credit. Pre: 2114. (3H,3C)

3654 (CMDA 3654) (STAT 3654): INTRODUCTORY DATA ANALYTICS & VISUALIZATION
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias. Pre: (1114 or 1044 or 1054 or 1064), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005), (STAT 3006 or STAT 4705 or STAT 4714 or CMDA 2006). (3H,3C)

3704: INTERMEDIATE SOFTWARE DESIGN AND ENGINEERING
Explores the principles of software design in detail, with an emphasis on software engineering aspects. Includes exposure of software lifecycle activities including design, coding, testing, debugging, and maintenance, highlighting how design affects these activities. Peer reviews, designing for software reuse, CASE tools, and writing software to specifications are also covered. A grade of C or better required in CS prerequisite 3114. Pre: 3114. (3H,3C)

3714: MOBILE SOFTWARE DEVELOPMENT
Technologies and concepts underlying software development for mobile devices (handheld computers). Mobile computing platforms, including architecture, operating system, and programming environment. Software design patterns and structuring for mobile applications. Network-centric mobile software development. Data persistence. Programming for mobile device components such as cameras, recorders, accelerometer, gyroscope and antennas. Location-aware software development. A grade of C or better required in CS prerequisite. Pre: 2114. (3H,3C)

3724: INTRODUCTION TO HUMAN-COMPUTER INTERACTION
Survey of human-computer interaction concepts, theory, and practice. Basic components of human-computer interaction. Interdisciplinary underpinnings. Informed and critical evaluation of computer-based technology. User-oriented perspective, rather than system-oriented, with two thrusts: human (cognitive, social) and technological (input/output, interactions styles, devices). Design guidelines, evaluation methods, participatory design, communication between users and system developers. A grade of C or better required in CS prerequisite 2114. Pre: 1114 or 1044 or 1054 or 1064. (3H,3C)

3744: INTRODUCTION TO GUI PROGRAMMING AND GRAPHICS
Design and implementation of object-oriented graphical user interfaces (GUI) and two-dimensional computer graphics systems. Implementation methodologies including callbacks, handlers, event listeners, design patterns, layout managers, and architectural models. Mathematical foundations of computer graphics applied to fundamental algorithms for clipping, scan conversion, affine and convex linear transformations, projections, viewing, structuring, and modeling. A grade of C or better is required in CS pre-requisite 2114. Pre: 2114, (MATH 1114 or MATH 1114H or MATH 2114 or MATH 2114H), (MATH 1224 or MATH 1224H or MATH 2204 or MATH 2204H). (3H,3C)

3754: CLOUD SOFTWARE DEVELOPMENT
Fundamentals of cloud software development, including design patterns, application programming interfaces, and underlying middleware technologies. Development of distributed multi-tiered enterprise software applications that run on a server computer and are accessed using a web browser over the Internet on a network-connected computer such as desktop, laptop, or handheld computer (tablet, smartphone, or mobile device. A grade of C or better is required in prerequisite. Pre: 2114. (3H,3C)

3824: INTRODUCTION TO COMPUTATIONAL BIOLOGY AND BIOINFORMATICS
Introduction to computational biology and bioinformatics (CBB) through hands-on learning experiences. Emphasis on problem solving in CBB. Breadth of topics covering structural bioinformatics; modeling and simulation of biological networks; computational sequence analysis; algorithms for reconstructing phylogenies; computational systems biology; and data mining algorithms. Pre-requisite: Grade of C or better in CS 3114. Pre: 3114. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4104: DATA AND ALGORITHM ANALYSIS
Data structures and algorithms from an analytical perspective. Theoretical analysis of algorithm efficiency. Comparing algorithms with respect to space and run-time requirements. Analytical methods for describing theoretical and practical bounds on performance. Constraints affecting problem solvability. A grade of C or better is required in CS prerequisite 3114. Pre: 3114, (MATH 3034 or MATH 3134). (3H,3C)

4114: INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA THEORY
The course presents a study of formal languages and the correspondence between language classes and the automata that recognize them. Formal definitions of grammars and acceptors, deterministic and nondeterministic systems, grammar ambiguity, finite state and push-down automata, and normal forms will be discussed. Pre: MATH 3134 or MATH 3034. (3H,3C)

4124: THEORY OF COMPUTATION
Theoretical analysis of the computational process; fundamental concepts such as abstract programs, classes of computational machines and their equivalence, recursive function theory, unsolvable problems, Church's thesis, Kleene's theorem, program equivalence, and generability, acceptability, decidability will be covered. Pre: MATH 3134 or MATH 3034. (3H,3C)

4164 (BIT 4164) (PSCI 4164): FUTURE OF SECURITY: INTEGRATIVE SOLUTIONS FOR COMPLEX SECURITY SYSTEMS
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events. Pre: PSCI 2164 or BIT 2164 or CS 2164. (3H,3C)

4204: COMPUTER GRAPHICS
Hardware and software techniques for the display of graphical information. 2D and 3D geometry and transformations, clipping and windowing, software systems. Interactive graphics, shading, hidden surface elimination, perspective depth. Modeling and realism. A grade of C or better required in CS prerequisite 3114 and 3744. Pre: 3114, 3744. (3H,3C)

4214: SIMULATION AND MODELING
Overview of discrete-event digital computer simulation and modeling. Fundamentals of model development, Monte Carlo simulation, the life cycle of a simulation study, input and output data analysis, world views and time control, random number and variate generation, credibility assessment of simulation results, simulation languages, applications of simulation using the General Purpose Simulation System (GPSS). A grade of C or better required in CS prerequisite 2114. Pre: 2114. (3H,3C)

4234: PARALLEL COMPUTATION
Survey of parallel computer architectures, models of parallel computation, and interconnection networks. Parallel algorithm development and analysis. Programming paradigms and languages for parallel computation. Example applications. Performance measurement and evaluation. A grade of C or better required in CS prerequisite 3214. Pre: 3214. (3H,3C)

4244: INTERNET SOFTWARE DEVELOPMENT
Key technology underlying the World-Wide Web. Web architecture, including client and server design, network protocols, and related standards. Static and dynamic content, caching, state management, fault tolerance, error handling. Programming systems and abstractions, e.g., sockets, remote procedures, Web services, frameworks and component models. Document representations and processing. Security. Entrepreneurial issues and emerging technologies. A grade of C or better required in CS 3214 prerequisite. Pre: 3214. (3H,3C)

4254: COMPUTER NETWORK ARCHITECTURE AND PROGRAMMING

Introduction to computer network architecture, and methods for programming network services and applications (e.g. DNS, Email and MIME, http, SNMP, multimedia). Wired, wireless, and satellite network architectures. OSI protocol model, with an emphasis on upper layers. Congestion control, quality of service, routing. Internet protocol suite (e.g. IP, TCP, ARP, RARP). Server design (e.g. connectionless, concurrent). Network programming abstractions (e.g. XDR, remote procedure calls, sockets, DCOM). Case studies (e.g. TELNET). A grade of C or better required in CS prerequisite 3214. Pre: 3214. (3H,3C)

4264: PRINCIPLES OF COMPUTER SECURITY
Survey of computer problems and fundamental computer security design principles and models for software systems. Cryptographic models and methods. Modern cyber security techniques for robust computer operating systems, software, web applications, large-scale networks and data protection. Privacy models and techniques. Contemporary computer and network security examples. A grade of C or better is required in prerequisites. Pre: 3214 or (ECE 2500, ECE 3574). (3H,3C)

4284: SYSTEMS & NETWORKING CAPSTONE
Advanced topics in computer systems & networking, e.g. distributed and parallel processing, emerging architectures, novel systems management & networking design, fault- tolerance, and robust and secure data management. Team- based approach to solving open-ended computer systems & networking problems. Designing, implementing and documenting advanced computer/networking systems. A grade of C or better required in CS prerequisites. Pre: 3114, 3214. (3H,3C)

4304: COMPILER DESIGN AND IMPLEMENTATION
This course includes the theory, the design, and the implementation of a large language translator system. Lexical analysis, syntactic analysis, code generation, and optimization are emphasized. A grade of C or better required in CS prerequisite 3214. Pre: 3214. (3H,3C)

4414 (MATH 4414): ISSUES IN SCIENTIFIC COMPUTING
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines. Pre: (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006), MATH 3214, (CS 2114 or MATH 3054). (2H,3L,3C)

4504 (ECE 4504): COMPUTER ORGANIZATION
Overview of the structure, elements and analysis of modern enterprise computers. Performance evaluation of commercial computing. Past and emerging technology trends. Impact of parallelism at multiple levels of computer architecture. Memory and storage. Fundamental computer system descriptions, Amdahl’s Law, Flynn’s Taxonomy. A grade of C or better required in prerequisites. Pre: ECE 2500 or CS 3214. (3H,3C)

4570 (ECE 4570): WIRELESS NETWORKS AND MOBILE SYSTEMS
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects. Pre: 4254 or ECE 4564. (3H,3C)

4604: INTRODUCTION TO DATA BASE MANAGEMENT SYSTEMS
Emphasis on introduction of the basic data base models, corresponding logical and physical data structures, comparisons of models, logical data design, and data base usage. Terminology, historical evolution, relationships, implementation, data base personnel, future trends, applications, performance considerations, data integrity. Senior standing required. A grade of C or better required in CS prerequisite 3114. Pre: 3114. (3H,3C)

4624: MULTIMEDIA, HYPERTEXT AND INFORMATION ACCESS
Introduces the architectures, concepts, data, hardware, methods, models, software, standards, structures, technologies, and issues involved with: networked multimedia information and systems, hypertext and hypermedia, networked information videoconferencing, authoring/electronic publishing, and information access. Coverage includes how to capture, represent, link, store, compress, browse, search, retrieve,

manipulate, interact with, synchronize, perform, and present: text, drawings, still images, animations, audio, video, and their combinations (including in digital libraries). Pre: 3114. (3H,3C)

4634: DESIGN OF INFORMATION
Survey of the higher-order properties that allow data to become information, that is, to inform people. The course focuses on the analysis of user needs, user comprehension and local semantics; the design of information organization; and the design of information display appropriate to use and setting. A grade of C or better is required in CS prerequisites 3114 and 3724. Pre: 3114, 3724. (3H,3C)

4644: CREATIVE COMPUTING STUDIO
Capstone computer science course at the intersection of arts and technology. Intensive immersion in different approaches to digital arts such as game design, interactive art, digital music, and immersive virtual reality. Students work in teams to conduct an end-to-end integrative design project. A grade of C or better is required in prerequisite CS 3724. Pre: 3724. (3H,3C)

4654 (CMDA 4654) (STAT 4654): INTERMEDIATE DATA ANALYTICS AND MACHINE LEARNING
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regulations, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks. Pre: (STAT 3654 or CMDA 3654 or CS 3654), (STAT 3104 or STAT 4706 or CMDA 2006). (3H,3C)

4704: SOFTWARE ENGINEERING CAPSTONE
Senior project course integrating software engineering knowledge and skills acquired in previous courses. Team- based approach to problem formulation, requirements engineering, architecture, design, implementation, integration, documentation and delivery of software system that solves a real-world problem. Pre: A grade of C or better in CS 3704. Pre: 3704. (3H,3C)

4784: HUMAN-COMPUTER INTERACTION CAPSTONE
Advanced, project-based course in Human-Computer Interaction. Team-based, end-to-end, integrative interface design project drawn from area of expertise in the department, e.g., virtual reality, augmented reality, embodied cognition, visualization, semiotic engineering, game design, personal information management, mobile computing, design tools, educational technology, and digital democracy. Pre-requisite: Senior Standing required. A grade of C or better is required in CS pre-requisite 3724 and 3744 Pre: 3724, 3744. (3H,3C)

4804: INTRODUCTION TO ARTIFICIAL INTELLIGENCE
Overview of the areas of problem solving, game playing, and computer vision. Search trees and/or graphs, game trees, block world vision, syntactic pattern recognition, object matching, natural language, and robotics. Senior standing required. A grade of C or better required in CS prerequisite 3114. Pre: 3114. (3H,3C)

4824 (ECE 4424): MACHINE LEARNING
Algorithms and principles involved in machine learning; focus on perception problems arising in computer vision, natural language processing and robotics; fundamentals of representing uncertainty, learning from data, supervised learning, ensemble methods, unsupervised learning, structured models, learning theory and reinforcement learning; design and analysis of machine perception systems; design and implementation of a technical project applied to real-world datasets (images, text, robotics). A grade of C- or better in prerequisites. Pre: ECE 2574 or CS 2114, (STAT 4604 or STAT 4705 or STAT 4714). (3H,3C)

4884: COMPUTATIONAL BIOLOGY & BIOINFORMATICS CAPSTONE
Advanced topics in computational biology and bioinformatics (CBB). Team-based approach to solving open-ended problems in CBB. Projects drawn from areas of expertise in the department, e.g., algorithms for CBB, computational models for biological systems, analysis of structure-function relationships in biomolecules, genomic data analysis and data mining, computational genomics, systems biology. Design, implementation, documentation and presentation of solutions. A grade of C or better required in CS prerequisite 3824. Pre: 3824. (3H,3C)

4944: SEMINAR
Pass/Fail only. Pre: 3604. (1H,1C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Crop and Soil Environmental Sciences

Head: Michael Evans
Thomas B. Hutcheson, Jr. Professor: W. L. Daniels
W. G. Wysor Professor: C. Griffey
Professors: A. O. Abaye, M. J. Eick, E. H. Ervin, G. K. Evanylo, J. M. Goatley Jr., S. C. Hodges, R. O. Maquire, M. A. Saghai Maroof, W. E. Thomason, T. Thompson, K. Xia, and C. E. Zipper
Associate Professors: J. H. Fike, J. M. Galbraith, D. Holshouser, M.S. Reiter, B. F. Tracy, and C. A. Wilkinson
Assistant Professors: B. D. Badgley, W. H. Frame, T. Fukao, S. Li, M. Steele, R. Stewart, and B. Zhang
Affiliate Professor: A. Pereira
Adjunct Professors: R. F. Follett, J. E. Perry III, P. J. Thomas, R. W. Tiner, and M. J. Vepraskas
Undergraduate Program Director: Benjamin Tracy (231.8259, bftracy@vt.edu)

Web: **www.cses.vt.edu**

Overview

With the world's population now approaching 7 billion people, and expected to exceed 9 billion within 30 to 40 years, the demand for food is expected to double. Therefore, our ability to sustainably produce plants for food and aesthetic purposes is more crucial now than ever before. If you want to become a scientist with the skills and knowledge to grow crops or turfgrass to provide for human needs and improve environmental quality, then the Crop and Soil Sciences major at Virginia Tech is for you! In the CSS program, students learn the fundamentals of plant science and improvement, and soil and environmental stewardship for feeding the world, protecting the environment, and producing quality turfgrass. As a student majoring in Crop and Soil Sciences, you can count on quality academic programs relevant for today and tomorrow, opportunities for involvement and experience, and individual and personal attention from our award-winning faculty and staff. Our programs offer the rigor, flexibility, and practical knowledge that will help you succeed regardless of the path you choose. You will learn the fundamentals of soil, plant, and environmental sciences to prepare you for your career.

Agronomy Option

Students in this option concentrate on the biology and increasingly complex technology of food, feed, fuel, and fiber production. Graduates typically move into farming or into sales, consulting, and managerial positions that directly and indirectly support agricultural production, a most vital component of the world's economy.

Crop Genetics and Breeding Option

Producing better quality and higher yielding crops has been a long-standing objective of crop breeders. New techniques of genetic engineering are now being brought to bear on crop improvement. Students in this option learn the newest methods of molecular biology and are well prepared for careers in research and industry.

International Agriculture Option

The world's ever-expanding population must be fed; at the same time, we must be good stewards of the Earth's resources. Many countries have not been able to bring food production and resource conservation into balance. Students in the International Agriculture option are interested in finding simultaneous solutions to these concerns. Employment opportunities exist with various private and public agencies.

Turfgrass Management Option

Using basic principles of the natural sciences and agricultural technology, turf managers have skills that make them highly employable in golf-course management, athletic and recreational fields, lawn maintenance services, the landscaping industry, and sod production.

Requirements for a Major

All the curricula for the various options contain a core of courses to assist the student in developing knowledge and ability in basic sciences (biology and chemistry), computational skills (mathematics and statistics), communication skills (both writing and speaking), as well as crop, soil, and environmental sciences. A list of courses specified for each option may be obtained upon request from the department or at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree

requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Requirements for a Minor

The department offers minors in crop and soil environmental sciences, turfgrass management, environmental science and wetland science. The requirements for each include CSES/ENSC 3114 and 3124 (or 3134) and 15 or 16 more credit hours selected from courses from within and outside the department. Consult the department office (240 Smyth) or web site (**http://registrar.vt.edu/graduation-multi-brief/index1.html**) for more information on a minor.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Opportunities to Excel

Students with outstanding records can qualify for the Honors Program and graduate "in honors" in crop and soil environmental sciences. Other opportunities for personal and professional growth and for recognition include department-sponsored agronomy and turf clubs, membership in Alpha Zeta and Gamma Sigma Delta or other honoraries, and several scholarships. B.S. graduates are certifiable in the professional registry of the American Society of Agronomy.

Graduate courses and research opportunities lead to M.S. and Ph.D. specializations in the crop, soil, and environmental sciences. (See the **Graduate Catalog** for more information.)

Undergraduate Course Descriptions (CSES)

2244: AGRICULTURE, GLOBAL FOOD SECURITY AND HEALTH
Agriculture and food security within the larger context of applied agronomy, gender role, cultural and political aspects of food production, food policy, production contraints, and global population growth. Emphasis on gender iniquity and globalized food systems will be made. Service learning experience both local and global to promote career opportunity in international development. (3H,3C)

2434: CROP EVALUATION
Identification of more than 200 crops, weeds, seeds and crop diseases. Seed testing for purity according to the rules of the Association of Official Seed Analysts. Crops graded according to the official USDA grain grading standards. (6L,2C)

2444: AGRONOMIC CROPS
An introduction to crop production in Virginia, presenting basic climatic, crop, and soil characteristics and their relation to cropping systems. Introduces basic mechanical, chemical, and managerial tools of crop

production and examines feed quality and seed and forage storage. (3H,3C)

2564: TURFGRASS MANAGEMENT
Growth, development, adaptation, and selection of the major turfgrass species. Principles of establishment, mowing, nutrition, irrigation, cultivation, and pest control of lawns and utility turfs. Co: BIOL 1105. (2H,3L,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3114 (ENSC 3114) (GEOS 3614): SOILS
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant-and earth-science majors. Partially duplicates 3134. Pre: CHEM 1036. Co: 3124. (3H,3C)

3124 (ENSC 3124) (GEOS 3624): SOILS LABORATORY
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134. Co: 3114. (3L,1C)

3134 (ENSC 3134): SOILS IN THE LANDSCAPE
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS. (2H,3L,3C)

3144: SOIL DESCRIPTION AND INTERPRETATION
Describing, classifying, evaluating, and interpreting soil and site properties in the class and field. Local field trips supplement lecture and laboratory studies. Required for students interested in attending soil judging contests. Co: 3124, 3114. (1H,6L,3C)

3304 (GEOG 3304) (GEOS 3304): GEOMORPHOLOGY
Examines the variety of landforms that exist at the earth’s surface. Detailed investigation of major processes operating at the earth’s surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion. Pre: GEOG 1104 or GEOS 1004 or GEOS 2104. (3H,3C)

3444 (HORT 3444): WORLD CROPS AND CROPPING SYSTEMS
An introduction to world crops, their primary regions of production, the factors that determine where they are grown, and their economic importance, and how they are used in the human diet. Describes the various factors that can be managed to improve crop yields. Examines present and potential systems of farming for improved crop production in the major climatic and soil ecosystems of the world. Provides an opportunity to taste foods made in traditional and non-traditional ways from the crops hence from field to fork. Junior standing required. (2H,3L,3C)

3564: GOLF AND SPORTS TURF MANAGEMENT
Principles of turfgrass science and culture required for successful establishment and management of intensely utilized fine golf and sports turf surfaces. Pre: 2564. (3H,3C)

3614 (ENSC 3614): SOIL PHYSICAL AND HYDROLOGICAL PROPERTIES
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance. Pre: (3114, 3124) or (GEOS 3614, GEOS 3624). (3H,3C)

3634 (ENSC 3634): PHYSICS OF POLLUTION
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils. Pre: 3114, PHYS 2205, (MATH 2016 or MATH 2024). (3H,3C)

3644 (ENSC 3644): PLANT MATERIALS FOR ENVIRONMENTAL RESTORATION
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils. Pre: BIOL 1106. Co: 3114. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4134 (ENSC 4134): SOIL GENESIS AND CLASSIFICATION
Formation of soils across landscapes, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory. Pre: (3114, 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (3H,3C)

4144: PLANT BREEDING AND GENETICS
Genetic variation in plants and its importance in plant breeding, and comparisons of theories and procedures in breeding of self-pollinated versus cross-pollinated plants. (2H,3L,3C)

4164 (BIOL 4164) (ENSC 4164): ENVIRONMENTAL MICROBIOLOGY
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling. Pre: BIOL 2604. (2H,3L,3C)

4174: SOIL EVALUATION AND SAMPLING
Naming, describing, classifying, sampling, and interpreting soil and site properties in the field to assess environmental impacts and suitability under specific land use scenarios. Selecting and evaluating sites of representative soil resources across the landscape using accepted professional protocols, simulating workplace responsibilities and performance. Local and regional field trips and sampling projects provide professional skill development evaluated by practitioners and potential employers. Pre: 3114 or 3144. (2H,3L,3C)

4214: SOIL FERTILITY AND MANAGEMENT
Soil productivity and nutrients required for crop growth; fertilizer sources and nutrient reactions in soil; methods of fertilizer nutrient placement in major tillage systems; and interpretation of soil tests and plant analyses for determining crop nutrient requirements. Pre: 3114 or 3134. (3H,3C)

4314 (ENSC 4314): WATER QUALITY
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies. Pre: (ENSC 3604 or BIOL 4004), (MATH 2015 or MATH

1026), (BIOL 1105 or BIOL 1106), (C HEM 1035 or CHEM 1036). (3H,3C)

4324 (ENSC 4324): WATER QUALITY LABORATORY
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314. Pre: CHEM 1046. Co: 4314, ENSC 4314. (3L,1C)

4334 (FREC 4334): PRINCIPLES AND PRACTICE OF AGROFORESTRY
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects. (3H,3C)

4344: CROP PHYSIOLOGY AND ECOLOGY
Developmental and ecological processes important in cropping situations: seed physiology, root and canopy development, flowering, water stress, energy flow, competition; emphasis on physiological adaptations, limitations to yield, and yield-optimizing strategies. (3H,3C)

4354: ADVANCED AGRONOMIC CROPS
Survey of major agronomic crops grown in the Eastern US and their production including: corn, soybean, wheat, barley, cotton, peanut, tobacco and alfalfa. Covers impact of environmental conditions and management on crops, resource requirements for productivity, and effects on soil resources. (3H,3C)

4444 (ENSC 4444): MANAGED ECOSYSTEMS, ECOSYSTEM SERVICES, AND SUSTAINABILITY
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior Standing required. Pre: 3114 or 3134. (3H,3C)

4544: FORAGE CROP ECOLOGY
Species adaptation interrelated with soil, climatic, and biotic factors as associated with establishment, production, utilization, and nutritional value of forages. (3H,3C)

4644: LAND-BASED SYSTEMS FOR WASTE TREATMENT
Soils as a medium for waste treatment; potential for environmental degradation from biologicals and chemicals added to soils; development of land-based treatment and utilization systems for solid and liquid wastes; issues and concerns relating to large-scale applications of municipal and industrial wastes to land. (3H,3C)

4734 (CHEM 4734) (ENSC 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: 2114, 3124, CHEM 2514 or CHEM 2535, CHEM 2114, (MATH 2015 or MATH 1026). (3H,3C)

4764 (ENSC 4764): BIOREMEDIATION
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and wastewaters, as well as remediation of industrial waste streams. Pre: BIOL 2604. (3H,3C)

4774 (ENSC 4774): RECLAMATION OF DRASTICALLY DISTURBED LANDS
Remediation, rehabilitation, and revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and material analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage. Pre: 3114 or GEOS 3614 or ENSC 3114 or CSES 3134 or ENSC 3134 or CSES 3304 or GEOG 33 04 or GEOS 3304. (3H,3C)

4854 (ENSC 4854): WETLANDS SOILS AND MITIGATION

Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetlands functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetland soils are mandatory. Pre: (3114, 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (2H,3L,3C)

4864: CAPSTONE: CROP & SOIL SCIENCES
Experiential and discussion-based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan that is defended orally. Review available careers in the crop and soil sciences. Compose and critique resumes and cover letters. CSS majors only. Pre: Senior standing. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Dairy Science

Interim Department Head: B.A. Corl
Named Professors: M. D. Hanigan - David R. and Margaret Lincicome Professor, and K. F. Knowlton - Colonel Horace E. Alphin Professor of Dairy Science
Associate Professors: B. A. Corl and C. S. Petersson-Wolfe
Assistant Professors: R. Cockrum, K. M. Daniels, and G. Ferreira
Advanced Instructor: W.A. White
Lecturer: D.R. Winston
Career Advisor: K.F. Knowlton
Professor Emeritus: R. M. Akers, M. A. Barnes, B. G. Cassell, F. C. Gwazdauskas, J. H. Herbein, R.E. James, G. M. Jones, M. L. McGIlliard, R. L. Nebel, R.E. Pearson, C. E. Polan, R. G. Saacke, C. C. Stallings, and J. M. White

Web: **www.dasc.vt.edu**

Overview

The purpose of the dairy science program is to offer students the opportunity to prepare themselves for a

wide variety of careers by developing their technical and interpersonal skills. We offer a challenging yet flexible curriculum that can be individualized to meet the educational needs and interests of each student, counseling to assist each student in designing individual programs, and extracurricular activities to enhance development of interpersonal skills.

Students may select from three curricula: Dairy Business Management, Science/Pre-Veterinary, and Dual Emphasis. All options provide students with the opportunity to acquire a broad education in the sciences, social sciences, economics, mathematics, and communications while learning the basic principles of dairy enterprise management.

Dairy Business Management Option (DBM)

This is the most flexible curriculum, with at least 30 credits of electives. Suited to students with an interest in various fields of dairy production (herd manager, farm manager), allied agri-business industries (feed, genetics, equipment), agricultural communications, public relations, extension, breed fieldperson, and a variety of other positions. Graduates in this option have also gone on to careers in college instruction, elementary school instruction, bank investment management, feed sales, and milk marketing, to name a few.

Science/Pre-Vet Option (SPV)

This option is recommended for students who plan to continue into veterinary college or other graduate or professional schools, or who plan a career in quality control, laboratory work, or research and product development. It provides an excellent base in chemistry, mathematics, physics, biology and biochemistry for advanced study in many areas. Students are encouraged and mentored to apply for early admission to veterinary school.

Dual Emphasis Option (DUAL)

This is the most popular option and is recommended for students who plan to concentrate in more than one academic area as they prepare for future careers. Common minors and double majors that students may earn while completing their Dairy Science degree requirements include Agricultural Economics, Animal and Poultry Sciences, Biology, Crop and Soil Environmental Sciences, Spanish, Communications, Professional Writing, etc.

Opportunities to Excel

Nearly all Dairy Science students complete a second major or minor in Animal and Poultry Science, Agricultural Economics, Horticulture, Spanish, Business Communications, Food Science and Technology, or any of many other departments. Students are also encouraged to actively participate in extracurricular clubs, judging teams and the dairy management team. Ninety five percent of students complete at least on internship prior to graduation and nearly half complete undergraduate research, an independent study, or serve as a teaching assistant.

Active participation in research projects in lactation, genetics, nutrition, nutrient management, and management provide qualified students valuable research experience with departmental scientists as well as part-time employment opportunities. These opportunities are available to students in all options and enhance their preparation for advanced study and provide a better understanding of the research process.

The dairy science honors program offers outstanding students the opportunity to enrich and broaden their academic programs. Honors students work closely with individual faculty members in choosing honors classes, colloquia, independent study, and research projects. Graduation "in honors" requires successful completion of university honors requirements, a comprehensive oral examination, and an honors thesis.

Graduate programs of study leading to the M.S. and Ph.D. also are offered (see **Graduate Catalog**).

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Requirements for a Minor

Requirements include ALS 2304 (4 cr.), DASC 2474 (3 cr.), DASC 4374 (3 cr.), and nine additional credits in DASC electives.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Pathways) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (DASC)

1464: DAIRY CATTLE HANDLING
Safety in dairy cattle handling; animal behavior; care, housing, and managerial practices related to dairy cattle. Experiential activities. Herding, sorting, halter training, health scoring, and milking. (3L,1C)

1574: DAIRY SCIENCE FIRST YEAR EXPERIENCE
The scope of the dairy science undergraduate program, preparation for careers in dairy and related industries. Hands-on experience working with dairy cattle. Inquiry, problem solving, and integration of ideas and experiences with a focus on the dairy industry. (1H,1C)

2204: ENTREPRENEURSHIP IN ANIMAL AGRICULTURE
Impact of animal entrepreneurship on the US agricultural economy. Innovative products and services for the dairy and livestock industries. Strategic planning, human resources, production scheduling, marketing, and financial management for animal enterprises. Capital acquisition. Sensitivity analysis for key planning assumptions. Contingency planning and risk management. Identification of non-traditional career paths in the animal industry. Pre: Sophomore Standing. Pre: AAEC 1005. (3H,3C)

2474: DAIRY SCIENCE AND INDUSTRY
Sustainable production, processing, and marketing of milk and milk products domestically and globally. Biology of dairy cattle with emphasis on genetics, reproduction, lactation, and nutrition. Management of dairy herds. (3H,3C)

2484: DAIRY CATTLE EVALUATION
Critical appraisal of dairy cattle conformation and experience in linear trait scoring, linear trait relationships to profitability, competitive judging; written and oral justification; organization and conduct of shows and contests; showmanship. II. (6L,2C)

2664: PROFESSIONAL DISCOURSE AND CAREER DEVELOPMENT
Emphasis on writing and speaking skills for livestock industry or post-baccalaureate education. Self-marketing, job acquisition, press relations, and conduct of meetings and labor management techniques. (1H,1C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3134 (APSC 3134): ANIMAL AGRICULTURE AND THE ENVIRONMENT
Environmental issue associated with animal agriculture. Nutrient contamination of water resources, odor emission from livestock farms, environmental regulations affecting animal agriculture, and management practices to reduce the impacts of livestock farms on air and water quality. (3H,3C)

3274: APPLIED DAIRY CATTLE NUTRITION
Application of basic principles of nutrition in developing rations for dairy herds. Emphasis is placed on appropriate use of forages, ration formulation techniques, development of profitable rations, and ration delivery. Co: ALS 3204. (3H,3C)

3474: DAIRY INFORMATION SYSTEMS
Development, function, and use of dairy information systems including computerized performance testing programs for dairy cattle improvement and dairy herd management. Pre: Junior standing. Pre: 2474. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4174: APPLIED DAIRY CATTLE GENETICS
Application of genetic principles to dairy cattle improvement. Setting goals for genetic improvement, characteristics of traits included in selection, current methods of estimating breeding values, the role of artificial insemination and breed associations in genetic improvement, cattle genetics. Pre: ALS 3104. (3H,3C)

4274: DAIRY RATION FORMULATION
Develop entry level professional animal nutritionist skills; use customer and feed databases, use optimization algorithms to formulate least cost diets and feed mixes, simultaneous consideration of diet cost, animal product return, and environmental constraints; further develop intergrative thinking and problem solving skills. Co: 3274. (3L,1C)

4304 (APSC 4304): PRINCIPLES & PRACTICES OF BOVINE REPRODUCTION
Principles and techniques in reproductive physiology and herd management related to health, record keeping, estrus detection and synchronization, and ultrasonography. Ovarian function and superovulation, semen handling, artificial insemination and pregnancy detection are also considered. Pre: ALS 2304. (1H,3L,2C)

4374: PHYSIOLOGY OF LACTATION
Anatomy of the mammary gland and physiology of lactation in domestic and laboratory mammals with emphasis on dairy cattle. Mammary gland health and factors affecting lactation. Principles and techniques in dairy herd milking management. Pre: ALS 2304. (2H,3L,3C)

4384: MAMMARY IMMUNOLOGY
This course is designed to provide students with basic knowledge of immunology as related to diseases of the mammary gland. Concepts of mammary gland immunity, disease etiology, immunopathology, diagnosis and therapy will be covered with a focus on ungulate species. Host pathogen interactions,

solving problems, writing intensive, literature search. Pre: ALS 2304, ENGL 1106. (3H,3C)

4474: ADVANCED DAIRY MANAGEMENT EVALUATION
Students will learn to critically evaluate all aspects of dairy farm management on working farms. The assessment and recommendations will be developed using information gathered from herd production records and financial statements, visual observations at the farm, and an interview of the farm owner and workers. Data assessed will include milk, growth, health, reproduction, and culling records; cash flow and profit loss statements; nutrition and nutrient management records; and labor management structure. The assessments and reports will further develop integrative thinking, oral communication, and written communication skills. Pre: 3474, ALS 3104, ALS 3204, ALS 3304. Co: 4475. (6H,2C)

4475-4476: DAIRY ENTERPRISE MANAGEMENT
Decision strategies for modern dairy businesses. 4475: Emphasis on relationships of enterprises and techniques for evaluation of business alternatives, efficiency of production, and profit. Use of microcomputer software to support management decisions. 4476: Concentration on herd replacements, personnel, facilities and issues of management associated with rapidly changing national and international markets, environmental regulations, and computer applications. Group projects and hands-on management of university dairy herd. Pre: 2474 for 4475; (4475 or AAEC 3454), DASC 3474 for 4476. 4475: (3H,3C) 4476: (2H,3L,3C)

4664: TRANSLATING DAIRY SCIENCE
Analysis and interpretation of peer-reviewed literature in dairy science. Focus on dairy industry issues discussed in social media. Critical reasoning, information synthesis, and oral and written discourse. Paper presentations and discussion. Pre: Senior Standing Pre: 2664. (1H,1C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Electrical and Computer Engineering

Head and Roanoke Electric Steel Professor in Engineering: Luke Lester
University Distinguished Professor: F. C. Lee and D. Boroyevich
University Distinguished Professor Emeritus: A. G. Phadke
Alumni Distinguished Professor Emeritus: C. W. Bostian
Bradley Distinguished Professor Emeritus of Electromagnetics: G. S. Brown
Clayton Ayre Professor: A. Wang
Joseph R. Loring Professor in ECE: S. Rahman
Willis G. Worcester Professor in ECE: J. H. Reed
Thomas Phillips Professor Emeritus: W. L. Stutzman
Virginia Microelectronics Consortium Professor: M. Agah
James S. Tucker Professor in ECE: J. S. Lai
Grant A. Dove Professor: Yue (Joseph) Wang
Professor Emeritus: J. R. Armstrong, I. M. Besieris, R. P. Broadwater, W. A. Davis, D. A. deWolf, F. G. Gray, T. Pratt, K. Ramu, S. M. Riad, F. W. Stephenson, J. S. Thorp, and H. F. VanLandingham
Associate Professor Emeritus: R. W. Conners, W. R. Cyre, R. L. Moose, and C. E. Nunnally
Professors: A. L. Abbott, M. Agah, P. Ampadu, P. M. Athanas, S. M. Bailey, A. A. Beex, R. M. Buehrer, C. R. Clauer, G.D. Earle, D. S. Ha, Y. T. Hou, M. S. Hsiao, M. T. Jones, G. Q. Lu, T. L. Martin, T. Mayer, S. F. Midkiff, L. M. Mili, K. Ngo, J-M. Park, P. Plassmann, T. C. Poon, S. Raman, B. Ravindran, J. M. Ruohoniemi, A. Safaai-Jazi, W. A. Scales, P. Schaumont, D. J. Stilwell, H. Wang, Y. Xu, Y. Yang, and J. Xuan
Associate Professors: A. L. Abbott, W. T. Baumann, R. Burgos, V. A. Centeno, S. W. Ellingson, L. J. Guido, J. De La Ree Lopez, H. Dhillon, M. Hudait, Q. Li, L. Liu, M. Manteghi, A. Mehrizi-Sani, L. Nazhandali, W. G. Odendaal, C. D. Patterson, J. Paul, W. Saad, C. Wang, C. L. Wyatt, and G. Yu
Collegiate Associate Professor: J. Mayer, A. M. Boker, K. Cooper
Collegiate Professor: C. Jones, V. Kovanis
Assistant Professors: T. Chantem, D. Bhatra, R. Gerdes, M. Ghassemi, X. Jia, K.J. Koh, Ch. Min, R. J. Moran, D. Parikh, R. Williams, Yang(Cindy) Yi, H. Zeng, W. Zhou, Yizheng

Zhu, and Yunhui Zhu
Assistant Professor of PracticeL P. Han
Professors of Practice: K. Giles, G. Manzo, and K. R. Schulz
Advanced Instructors: D. McPherson and J. Thweatt
Instructors: A. Ball, Md A. Sarkar and S. (William) Yu

Web: **www.ece.vt.edu**

Overview

The Bradley Department of Electrical and Computer Engineering offers bachelor of science degrees in electrical engineering (EE) and computer engineering (CPE). The difference between these two degrees is one of emphasis. Electrical engineering concentrates on physical processes and design in communications and networking; energy and power electronics systems; controls, robotics, and autonomy; micro- and nanoelectronics; space systems; RF and microwaves; and photonics. Computer engineering emphasizes the development of computer hardware and associated technical areas, such as networks and cybersecurity; machine learning; chip-scale integration; controls, robotics and autonomy; and software systems. In addition to undergraduate degrees, the department also offers M.S., M.Eng., and Ph.D. programs in both EE and CPE. An accelerated undergraduate/graduate (UG/G) program is available for qualified undergraduates.

Electrical engineers (EEs) and computer engineers (CPEs) create important and exciting technologies, systems and applications that make the world a better place for all of us. EEs and CPEs are inventing new ways to generate, distribute and use electric power that are more efficient, more sustainable and friendlier to the environment. For example, wider use of solar energy relies on improved photovoltaic devices, power electronics for energy conversion, and power grids. Some of our most critical global infrastructures, including the Internet, mobile voice and data networks, and the electric power grid are designed by EEs and CPEs. And, EEs and CPEs design sensors and embedded systems to monitor intelligent buildings and transportation systems. Applying innovative technologies to biology and the healthcare industry, EEs and CPEs create techniques for medical imaging, micro-electromechanical systems for medical diagnostics, implantable devices for health monitoring and drug delivery, and information systems to improve healthcare delivery. To meet the challenge of cybersecurity, EEs and CPEs design hardware and software for cryptographic algorithms and develop methods to ensure private communications through the Internet and wireless devices. They design new devices and systems for high-performance computing and networking. They build satellites and instruments to improve communications and enhance our knowledge of space and the Earth. And, EEs and CPEs enhance our leisure time by creating new ways to listen to music, watch movies, play games, communicate with friends, and build social networks.

Students in the Bradley Department of Electrical and Computer Engineering learn from faculty who work at the cutting-edge of engineering research and bring the excitement of their discoveries to the classroom. Engineers want to make things that work. EE and CPE students get hands-on opportunities to build components and systems from the beginning of their studies. In the freshman year, students explore applications of electrical and computer engineering, such as medical imaging and cryptography. In the sophomore year, EE and CPE students use personal, portable equipment and components to build and explore simple digital and analog electronic systems, which become more complex each semester. Laboratories and team projects throughout the curriculum contribute to an enriching hands-on, minds-on learning experience. By their senior year, students have the option of participating in a team-based, industry-sponsored design project that spans two semesters in which they solve real-world engineering problems while learning project management and team-building skills.

Electrical engineering and computer engineering are dynamic and fast changing fields that drive

innovation and solutions to global challenges. The ECE faculty has created a program of study that provides each graduate with a firm foundation in mathematics, physics, and engineering principles, and with broad experience in different areas of EE and CPE. The program enables our graduates to excel in their EE and CPE specialties, while gaining the tools to adapt to the technical changes and career opportunities they will experience in the future. EE and CPE students develop effective communication and teamwork skills and gain knowledge of ethics, all of which are essential to professional success. EE and CPE graduates are prepared to pursue careers in industry and government, advanced graduate work in EE and CPE, and other advanced professional degrees.

ECE seeks to develop tomorrow's engineering and technical leaders and innovators. Students can enhance their undergraduate experience by participating in multidisciplinary team projects, cooperative education and internships, research experiences for undergraduates, study abroad programs, dual degree and minor programs in other fields, and mentoring programs. The Cooperative Education (co-op) and Internship Program is highly recommended, as is participation in professional societies, including the Institute of Electrical and Electronics Engineers (IEEE), Eta Kappa Nu (HKN) and the Association for Computing Machinery (ACM). ECE works with the Ted and Karyn Hume Center for National Security and Technology to develop future leaders for the US government. ECE offers many scholarships for academic excellence, leadership and service, as well as for participation in various special academic programs.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (ECE)

1004: INTRODUCTION TO ECE CONCEPTS
Introduction to topics that span the field of electrical and computer engineering (ECE). Content presented through the lens of application with accompanying hands-on exercises. Basics of circuits, op-amps, power supplies, computer logic, system decomposition, and coding. Modeling and application of engineering professionalism. Exploration of ECE in society. Pre: ENGE 1215 (C- or better) Co: MATH 1114 or MATH 2114 Pre: ENGE 1215. (3H,3C)

1574: OBJECT-ORIENTED ENGINEERING PROBLEM SOLVING WITH C++
Problem solving techniques for engineering problems, primarily from the fields of electrical and computer engineering; procedural and object-oriented program development, editing, compiling, linking, and debugging using the C++ programming language. Must have C- or better in the prerequisites. Pre: (ENGE 1024 or ENGE 1215 or ENGE 1414), MATH 1205 or (MATH 1205H or MATH 1225). (2H,2L,3C)

2004: ELECTRIC CIRCUIT ANALYSIS
Introduction to the basic laws and techniques for the analysis of electric circuits. Calculation of the response of circuits with resistors, independent sources, controlled sources, and operational amplifiers. The transient analysis of basic circuits with R, L, and C components. An introduction to AC analysis and phasors. Pre: ENGE 1104 or ENGE 1204 or ENGE 1114 or ENGE 1216 or ENGE 1414. Co: MATH 2214. (3H,3C)

2014: ENGINEERING PROFESSIONALISM IN ECE

Overview of the nature and scope of the electrical and computer engineering profession. Working in a diverse team environment; professional and ethical responsibility; the impact of engineering solutions in a global and societal context; contemporary issues; and life-long learning. Sophomore standing required. Co: 2004 or 2504. (2H,2C)

2024: CIRCUITS AND DEVICES
Analysis and design of passive and active circuits under Direct Current (DC), Alternating Current (AC), and switched excitation. Linear circuit analysis techniques for various circuit topologies. Expressing the transient response of first- and second-order linear circuits using time-domain methods. Calculating the AC steady-state response of linear circuits using phasors and immittances. Characterizing the frequency response of linear circuits. Determining operating point and small signal response of non-linear circuits containing diodes and bipolar transistors. Projects demonstrating circuit design processes adhering to professional practices. Pre: 1004, MATH 2114. Co: 2514, 2544, MATH 2214, PHYS 2306. (3H,3C)

2054: APPLIED ELECTRICAL THEORY
For students in the Mechanical Engineering program or by permission of the ECE Department. Fundamentals of electric circuits; circuit laws and network theorems, operational amplifiers, energy storage elements, response of first and second order systems, AC steady state analysis. Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system. Pre: PHYS 2306. Co: MATH 2214. (2H,2L,3C)

2074: ELECTRIC CIRCUIT ANALYSIS LABORATORY
Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system. Experiments include: characterization of breadboard backplane wiring; component tolerances; Ohm's law; Kirchoff's laws; series and parallel resistors; voltage and current dividers; delta-wye configurations; mesh-current and node- voltage analysis; superposition and Thevenin equivalents; inverting and non-inverting amplifier circuits; series RC and RL circuits; discharging LEDs and integrator and differentiator circuits. Introductory design experiments include a simple voltmeter and a flashing traffic arrow. Must have a C- or better in prerequisites. Pre: ENGE 1104 or ENGE 1204 or ENGE 1114 or ENGE 1216 or ENGE 1414. Co: 2004, MATH 2214. (3L,1C)

2164 (AOE 2664): EXPLORATION OF THE SPACE ENVIRONMENT
This introductory course covers a broad range of scientific, engineering, and societal aspects associated with the exploration and technological exploitation of space. Topics covered include: science of the space environment; space weather hazards and societal impacts; orbital mechanics and rocket propulsion; spacecraft subsystems; applications of space-based technologies. (3H,3C)

2204: ELECTRONICS
Introduction to basic electronic devices including diodes and transistors and their operating principles. Analysis of electronic circuits operating under dc bias and switching conditions. Applications of devices in digital electronic circuits. Must have a C- or better in prerequisite. Pre: 2004. (3H,3C)

2274: ELECTRONIC NETWORKS LABORATORY I
Principles of operation of electrical and electronic test equipment and applications to measurement of circuit parameters. Transient and steady state response of RLC networks. Applications of laws and theories of circuits. Design, prototyping, and testing of electronic devices and circuits. Must have C- or better in prerequisite. Pre: 2074. Co: 2204. (3L,1C)

2500: COMPUTER ORGANIZATION AND ARCHITECTURE
Computer organization and architecture: instruction formats and construction; addressing modes; memory hierarchy (cache, main memory and secondary memory) operation and performance; simple pipelines; basic performance analysis; simple OS functions, particularly as they relate to hardware; virtual memory; computer I/O concepts, including interrupt and DMA mechanisms; intercomputer communication concepts. Must have C- or better in prerequisite 2504. Pre: 2504. (3H,3C)

2504: INTRODUCTION TO COMPUTER ENGINEERING
An introduction to the design and operation of digital computers, including information representation, logic design, integrated circuits, register transfer description, hardware description languages, basic

computer organization and assembly-level programming. The relationship between software and hardware is stressed. This course duplicates material in CS2504 and may not be taken for credit towards graduation if CS2504 is also taken. Pre: 1574. (3H,3C)

2514: COMPUTATIONAL ENGINEERING
Software development processes for electrical and computer engineering applications. Modeling, simulation, data analysis, and visualization. Computing abstractions and the use of application programming interfaces. Software design and implementation using a procedural, class-based language. Integrated code development and testing. Team-based development of autonomous system applications reinforcing course topics. Pre: 1004. Co: 2544, 2024. (3H,3C)

2524: INTRODUCTION TO UNIX FOR ENGINEERS
Fundamental concepts of operating systems, emphasizing a hands-on introduction to UNIX. User interfaces, UNIX shell commands, the UNIX file system, task management, common system utilities, the UNIX programming environment. Students gain experience with system installation and administration. Duplicates CS 2204. Must have C- or better in prerequisite 2574. Pre: 2574. (2H,2C)

2534: MICROCONTROLLER PROGRAMMING AND INTERFACING
Operation and applications of microcontrollers, including system level organization, analysis of specific processors, and software and hardware interface design. Pre: 2504. (3H,3L,4C)

2544: FUNDAMENTALS OF DIGITAL SYSTEMS
Design and analysis of digital systems. Information representations and computer arithmetic. Switch and gate design within digital logic. Combinational logic analysis and synthesis, Hardware Description Languages (HDL), and hierarchical design. Finite-state machines, synchronous sequential logic analysis and design. Hardware specification and documentation. Register transfer level architectures, computer organization, memories, and digital interfacing. Instruction set architecture and assembly language programming. Emphasis on the relationship between software and hardware. Pre: 1004. Co: 2514, 2024. (3H,3C)

2574: DATA STRUCTURES AND ALGORITHMS
Introduces fundamental data structures, algorithms, and abstract data types. Main topics include data structures such as arrays, linked lists, stacks, queues, graphs, and trees, and algorithms such as those that are used for list manipulation, graph searches, sorting, searching, and tree traversals. Implementation of data structures and algorithms in C++. C- or better in prerequisites. Pre: 1574. (3H,3C)

2704: SIGNALS AND SYSTEMS
Analysis techniques for signals and systems. Signal representation, including Fourier and LaPlace transforms. System definitions and properties, such as linearity, causality, time invariance, and stability. Use of convolution, transfer functions and frequency response to determine system response. Applications to circuit analysis. Hands-on projects to illustrate and integrate the various concepts. C- or better in prerequisites. Pre: (2004 or 2004H), 2074, (MATH 2214 or MATH 2214H). (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
A minimum GPA of 2.0 in all ECE courses is required for enrollment. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: AC CIRCUIT ANALYSIS
Application of the basic laws and techniques of circuit analysis to AC circuits. Complex numbers and algebra with an emphasis on phasor representation of circuits. Calculation of the frequency response of circuits with R, L, and C components, independent sources, controlled sources, and operational amplifiers. Analysis of AC steady-state circuits and determination of average power. Magnetically coupled circuits. Laplace and Fourier transforms. Representation of circuits by two-port models. C- or better in prerequisites. Pre: 2704. (3H,3C)

3054: ELECTRICAL THEORY
For students in curricula other than ECE. Fundamentals of electric circuits and electronic devices. Specific topics include linear AC and DC circuit analysis, transistors, operational amplifiers, reactive linear elements, filters, transformers, Boolean algebra, combinatorial logic gates, and basic sequential logic devices. Principles of Electromagnetics and its application to antenna systems. Pre: PHYS 2305. Co: MATH 2214. (3H,3C)

3074: AC CIRCUIT ANALYSIS LABORATORY
Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system. Experiments include: sinusoids and phasors including impedance, admittance, and Kirchhoff's laws; sinusoidal steady- state including node and mesh analysis, Thevenin and Norton equivalent, and op amps; ac power analysis including instantaneous and average power, power factor, and complex power; magnetically coupled circuits including mutual inductance, energy in a coupled circuit, and transformers; frequency response including transfer functions, Bode plots, resonance, and passive and active filters; and two-port circuits. A C- or better is required for all prerequisites. Pre: 2074. Co: 3004. (3L,1C)

3104: INTRODUCTION TO SPACE SYSTEMS AND TECHNOLOGIES
Introduction to technologies and computational tools used in space-based applications, including techniques for exploring the planets and the near-Earth geospace environment. Overview of orbits, spacecraft, control of spacecraft, electromechanical system requirements for space-based applications, and space environment interactions with spacecraft systems. Understanding the space environment and the engineering approaches required to operate it. A C- or better is required in prerequisites. Pre: (2204, 3105) or 3054. (3H,3C)

3105-3106: ELECTROMAGNETIC FIELDS
Maxwell's equations and their application to engineering problems. ECE 3105: transmission lines, introductory electrostatics, introductory magnetostatics, Faraday's Law, properties of uniform plane waves. ECE 3106: electrostatics and magnetostatics, Maxwell's Equations, wave propagation in uniform media, the reflection and transmission of plane waves, guided waves, radiation. A C- or better is required in the prerequisites. Pre: 2004, MATH 2204, PHYS 2306 for 3105; 3105 for 3106. (3H,3C)

3134: INTRODUCTION TO OPTOELECTRONICS
Fundamental principles of optoelectronics. The concept of photons, spontaneous emission, and simulated emission. Rate equation analysis of light emitting diodes and lasers. Operation principles and device characteristics of photodetectors and solar cells. Advanced topics such as quantum well and emerging materials. Pre: 2204. (3H,3C)

3154: SPACE SYSTEMS - DESIGN AND VALIDATION
Introduction to systems and techniques used in electrical engineering design for space-based applications. Students design, fabricate, and test an electronic system following accepted NASA and industry standards, including functional bench-top tests, thermal testing, vibration testing, and long-duration operational testing. Periodic formal reports will document design approaches and test results. Pre: 3105. Co: 3104. (1H,3L,2C)

3174: OPTOELECTRONICS LABORATORY
Characterization of optoelectronic devices such as light emitting diodes, semiconductor lasers, and photodetectors. Characterization and analysis of optical interference, wave propogation in optical fibers, and optical diffraction. Construction of simple optical imaging systems using lenses and bulk optics. Pre: 2274. Co: 3134. (3L,1C)

3204: ANALOG ELECTRONICS
Small signal modeling of transistors. Basic architecture and functionality of linear amplifiers including transistor biasing circuits, current sources, differential amplifier, common emitter amplifier, common source amplifier, emitter follower, source follower, common base amplifier, and common gate amplifier. Frequency response of single stage and multistage amplifiers. Pre: 2204, 2704. (3H,3C)

3214: SEMICONDUCTOR DEVICE FUNDAMENTALS

Fundamental semiconductor device physics associated with intrinsic and doped semiconductor materials, drift-diffusion of charge carriers, and devices with an in-depth coverage of p-n and Schottky diodes, bipolar junction transistors, and metal-oxide semiconductor and junction field effect transistors. Pre: 2204 or MSE 3204. (3H,3C)

3254: INDUSTRIAL ELECTRONICS
Fundamentals of electronics, including basic device principles. Include digital, operational amplifier, and analog analysis for industrial applications and magnetic circuits. For students in the Mechanical Engineering program or by permission of the ECE Department. Pre: 2054. (3H,3C)

3274: ELECTRONIC CIRCUITS LABORATORY II
Design, build, and test amplifiers and other electronic circuits to meet specifications. Bipolar and field-effect transistors, diodes, integrated circuits such as operational amplifiers, and passive components are used. Gain, bandwidth, input and output impedance, positive and negative feedback, and circuit stability are implemented in the designs. Digital oscilloscopes, ammeters, voltmeters, function generators, and power supplies are used. A grade of C- or better is required in all pre-requisite courses. Pre: 2274, 3074. Co: 3204. (3L,1C)

3304: INTRODUCTION TO POWER SYSTEMS
Basic concepts of AC systems, single-phase and three-phase networks, electric power generation, transformers, transmission lines, electric machinery and the use of power. Pre-requisite 3004 with C- or better. Pre: 3004. (3H,3C)

3354: ELECTRIC POWER ENGINEERING LABORATORY
Laboratory experiments based on principles of electric power engineering. Co: 3304. (3L,1C)

3544: DIGITAL DESIGN I
Design techniques for combinational and sequential logic. Design of digital circuits using standard integrated circuit chips and programmable logic devices. Computer simulation will be used to validate designs. Prototypes will be constructed to demonstrate design functionality. Pre: 2504. (3H,3L,4C)

3574: APPLIED SOFTWARE DESIGN
An introduction to applied software design methods for use in the writing of efficient, reusable, and modular C++ programs. Introduces the use of the following: classes, inheritance, and polymorphism; design patterns; high-level programming techniques using libraries, generics, and containers; widgets, models, and views; software frameworks for embedded systems; and advanced techniques ranging from multi-threading to reflective programming. Pre: 2574. (3H,3C)

3604: INTRODUCTION TO RF & MICROWAVE ENGINEERING
Introduction to circuits, devices, and systems for radio frequency (RF) and microwave applications. Fundamentals of antennas, propagation, small signal and power amplifiers, frequency conversion, and frequency synthesis. Tools and concepts including s-parameters, design impedance matching, dynamic range, noise figure, and link budget. Pre: 2204, 3105. (3H,3C)

3614: INTRODUCTION TO COMMUNICATION SYSTEMS
Analysis and design of analog and digital communication systems based on Fourier analysis. Topics include linear systems and filtering, power and energy spectral density, basic analog modulation techniques, quantization of analog signals, line coding, pulse shaping, and transmitter and receiver design concepts. Applications include AM and FM radio, television, digital communications, and frequency-division and time-division multiplexing. Pre: 2704, STAT 4714. (3H,3C)

3704: CONTINUOUS AND DISCRETE SYSTEM THEORY
Continuous- and discrete-time system theory. Block diagrams, feedback, and stability theory. System analysis with Bode diagrams. Discrete-time stability, difference equations, Z-transforms, transfer functions, Fourier transforms, and frequency response. Sampling of continuous systems and an introduction to digital filtering. Hands-on projects to illustrate and integrate the various continuous- and discrete-time concepts and tools. Pre: 2704. (3H,3C)

3714: INTRODUCTION TO CONTROL SYSTEMS

Introduction to the design of feedback compensation to improve the transient and steady-state performance of systems. Emphasis is on modeling, analysis and analog compensator design for single-input single-output systems. Modeling techniques, root locus analysis and design, the Nyquist criterion, and frequency domain compensation. Pre: 2704. (3H,3C)

3964: FIELD STUDY
Variable credit course.

3974: INDEPENDENT STUDY
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4104: MICROWAVE AND RF ENGINEERING
Passive and active Radio Frequency and microwave components and circuits for wireless communications; transmission-line theory; planar transmission-lines and waveguides; S-parameters; resonators; power dividers and couplers; microwave filters; sources, detectors, and active devices; modern RF & microwave CAD; measurement techniques. C- or better in prerequisites. Pre: 3106, 3204. (3H,3L,4C)

4114: ANTENNAS
Antenna fundamentals, analysis and design principles, and a survey of antenna types including: arrays, wire antennas, broadband antennas, and aperture antennas. Pre: 3106. (3H,3C)

4124: RADIO WAVE PROPAGATION
Behavior of radiated electromagnetic waves in terrestrial, atmosphere, space, and urban environments; path, frequency and antenna selection for practical communication systems; propagation prediction. Pre: 3106. (3H,3C)

4134: PHOTONICS
Fundamental concepts in photonics technology. Basic principles of optical fibers and components such as Bragg gratings, amplifiers, couplers and modulators used in optical communications and sensing. Propagation, dispersion, bandwidth and nonlinear properties of optical signals in optical waveguides and fibers. Pre: 3106. (3H,3C)

4144: OPTICAL SYSTEMS
Fundamental concepts in optical information processing. Ray optics. Optical diffraction. Basic principles and applications of optical imaging using wave optics. Properties of Gaussian Beam. Introduction to Fourier optics, optical spatial filtering, 3D image reconstruction and holography. Pre: 3105. (3H,3C)

4154 (AOE 4654): SPACE WEATHER: THE SOLAR WIND AND MAGNETOSPHERE
Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earth’s magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation. Pre: 3105 or AOE 3014. (3H,3C)

4164: INTRODUCTION TO GLOBAL POSITIONING SYSTEM (GPS) THEORY AND DESIGN
Fundamental theory and applications of radio navigation with the Global Positioning System GPS. Satellite orbit theory, GPS signal structure and theory, point positioning with pseudoranges and carrier phases, selective availability, dilution of precision, differential GPS, atmospheric effects on GPS signals. Pre: (3105, 2014) or AOE 4134. (3H,3L,4C)

4194: ENGINEERING PRINCIPLES OF REMOTE SENSING
Physical principles involved in remote sensing of Earth’s environment and their implementation in engineering systems: fundamentals of electromagnetic wave propagation, scattering by matter, effects of propagation media, passive and active systems, remote sensing platforms, data processing, systems integration, and introductory concepts important for the design and analysis of remote sensing engineering systems. Pre: 3106. (3H,3C)

4205-4206: ELECTRONIC CIRCUIT DESIGN
Stability and response of feedback amplifier, wideband amplifiers, operational amplifier characteristics, waveform generators and wave shaping, nonlinear circuit applications, signal generators, and photolithography. Design of analog electronic circuits, circuit simulation, response characterization, and printed circuit construction. C- or better in prerequisites. Pre: 3204 for 4205; 4205 for 4206. (3H,3C)

4220: ANALOG INTEGRATED CIRCUIT DESIGN
Integrated circuit design in silicon bipolar, MOS (Metal-Oxide-Semiconductor), and BiCMOS (Bipolar Complementary Metal-Oxide-Semiconductor) technologies for communications, sensor, instrumentation, data conversion, and power management applications. Models for active devices in bipolar and MOS technologies; transistor-level amplifiers and output stages (amplifier classifications); transistor-level current mirrors and voltage reference generators, transistor-level operational amplifiers; transistor-level feedback circuits; noise and linearity; layout and simulation of analog integrated circuits with modern VLSI CAD (Very Large Scale Integration- Computer Aided Design) software. Pre: 3204. (3H,3C)

4224: POWER ELECTRONICS
Power devices and switching power converters including rectifiers and inverters; design of electronic power processing circuits and their control as applied to computer, telecommunication, transportation, and industrial systems. A C- or better is required in all prerequisites. Pre: 3204. (3H,3C)

4234 (MSE 4234): SEMICONDUCTOR PROCESSING
Manufacturing practices used in silicon integrated circuit fabrication and the underlying scientific basis for these process technologies. Physical models are developed to explain basic fabrication steps, such as substrate growth, thermal oxidation, dopant diffusion, ion implantation, thin film deposition, etching, and lithography. The overall CMOS integrated circuit process flow is described within the context of these physical models. Pre: 2204 or 3054. (3H,3C)

4244: INTERMEDIATE SEMICONDUCTOR PROCESSING LABORATORY
Design, layout, fabricate, and characterize microelectronic devices. Analyze test results to verify performance to the predetermined specifications. Required oral and written reports. A C- or higher is required in all pre-requisite courses. Pre: (4234 or MSE 4234). (1H,6L,3C)

4284: POWER ELECTRONICS LABORATORY
Design and testing of electronic power processing systems for commercial and aerospace applications. Co: 4224. (3L,1C)

4304: DESIGN IN POWER ENGINEERING
A study of the principles in electric power engineering. Expert systems, superconductivity, DC transmission, motor control, system protection, high performance motors, solar energy, microcomputer applications, machine design, computer-aided design, digital relaying and space station application. Pre: 3304. (3H,3C)

4334: POWER SYSTEM ANALYSIS AND CONTROL
Development of methods for power analysis and control. An analysis and design of systems for steady state, transient, and dynamic conditions. Digital solutions emphasized. Pre: 3304. (3H,3C)

4344: ELECTRIC POWER QUALITY FOR THE DIGITAL ECONOMY
Causes, consequences and solutions of power quality problems that affect the operation of computerized processes and electronic systems. Industry standards, monitoring techniques and economic consideration of power quality issues. Pre: 3304. (3H,3C)

4354: POWER SYSTEM PROTECTION
Protection of power apparatus and systems. Fuses. Voltage and current transducers. Relays. Coordination of relays. Pilot channels. Grounding practices. Surge phenomena. Insulation coordination. Pre: 4334. (3H,3C)

4364: ALTERNATE ENERGY SYSTEMS
Electric energy from alternative energy sources including solar, wind, hydro, biomass, geothermal and

ocean. Characteristics of direct conversion, electromechanical conversion, and storage devices used in alternative energy systems. Power system issues associated with integration of small scale energy sources into the electricity grid. Pre: STAT 4714. (3H,3C)

4374: POWER SYSTEM PROTECTION LABORATORY
Experimental verification of principles and practice of protective relaying. Experiments and design projects to demonstrate the principles and techniques of industrial power system design. Fuses, time overcurrent, and instantaneous relays. Differential relaying for transformers. Distance relaying. Current and voltage transformers. Pre: 4334. Co: 4354. (3L,1C)

4424 (CS 4824): MACHINE LEARNING
Algorithms and principles involved in machine learning; focus on perception problems arising in computer vision, natural language processing and robotics; fundamentals of representing uncertainty, learning from data, supervised learning, ensemble methods, unsupervised learning, structured models, learning theory and reinforcement learning; design and analysis of machine perception systems; design and implementation of a technical project applied to real-world datasets (images, text, robotics). A grade of C- or better in prerequisites. Pre: 2574 or CS 2114, (STAT 4604 or STAT 4705 or STAT 4714). (3H,3C)

4454: MULTIMEDIA SIGNAL PROCESSING
Signal processing techniques in multimedia systems: concept and principle of multimedia systems; speech analysis and recognition; audio/image/video compression; scene video analysis & understanding; multimedia applications such as human computer interaction, multimedia communication and multimedia security. Pre: 2704. (3H,3C)

4504 (CS 4504): COMPUTER ORGANIZATION
Overview of the structure, elements and analysis of modern enterprise computers. Performance evaluation of commercial computing. Past and emerging technology trends. Impact of parallelism at multiple levels of computer architecture. Memory and storage. Fundamental computer system descriptions, Amdahl's Law, Flynn's Taxonomy. A grade of C or better required in prerequisites. Pre: 2500 or CS 3214. (3H,3C)

4514: DIGITAL DESIGN II
Advanced digital design techniques for developing complex digital circuits. Emphasis on system-level concepts and high-level design representations while meeting design constraints such as performance, power, and area. Methods presented that are appropriate for use with automated synthesis systems. Commercial hardware description language simulation and synthesis tools used for designing a series of increasingly complex digital systems, and implementing those systems using Field Programmable Gate Arrays (FPGAs). Pre: 3544. (3H,3L,4C)

4520: DIGITAL AND MIXED-SIGNAL SYSTEM TESTING AND TESTABLE DESIGN
Various topics on testing and testable design for digital and mixed-signal systems are studied: fault modeling, logic and fault simulation, fault modeling, automatic test pattern generation, deterministic ATPG, simulation-based ATPG, delay fault testing, design for testability, built-in-self-test and fault diagnosis. Pre: 2574, (3504 or 3544). (3H,3C)

4524: ARTIFICIAL INTELLIGENCE AND ENGINEERING APPLICATIONS
Problem solving methods; problem spaces; search techniques; knowledge representation; programming languages for AI; games; predicate logic; knowledge-based systems; machine learning; planning techniques; reactive systems; artificial neural networks; natural language understanding; computer vision; robotics. Pre: 2574, STAT 4714. (3H,3L,4C)

4525-4526: VIDEO GAME DESIGN AND ENGINEERING
4525: Fundamental concepts in the development and engineering of modern 2-D and 3-D real-time interactive computer video games. Game design and engineering principles, game architecture, game mechanics and interaction, computer graphics, strategy, artificial intelligence (AI), optimization, play testing and fuzzy logic are included. 4526: Advanced concepts in the development and engineering of modern 2-D and 3-D real-time interactive computer video systems. Topics include non-player character (NPC) behavior learning, search and planning, player modeling, procedural content generation, AI-

assisted game design. Pre: 3574 for 4525; 4525 for 4526. (3H,3C)

4530: HARDWARE-SOFTWARE CODESIGN
An introduction to the design of mixed hardware- software systems, focusing on common underlying modeling concepts, the design of hardware-software interfaces, and the trade-offs between hardware and software components. Students will use simulation tools to conduct experiments with mixed hardware-software systems in the area of embedded systems. Pre: (3504 or 3544), 2534. (3H,3C)

4534: EMBEDDED SYSTEM DESIGN
Introduction to the design of embedded computer systems; design, implementation, and analysis of embedded computer hardware and software; design, implementation, and debugging of complex software applications on embedded systems; and fundamentals of real-time operating systems for embedded computers. Semester-long design project including written and oral presentations. C- or better required in prerequisites. Pre: 3574, 2534, 2014. (3H,3L,4C)

4540: VLSI CIRCUIT DESIGN
Introduction to the design and layout of Very Large Scale Integrated Circuits (VLSI). Emphasis is placed on digital CMOS circuits. Static and dynamic properties of MOSFET devices, along with integrated circuit fabrication are examined. Computer-aided design tools are used to produce working integrated circuit designs. Pre: 2204, 2504. (3H,3C)

4550: REAL-TIME SYSTEMS
Theory, algorithmic and protocol concepts, mechanisms, and implementations of real-time computer systems. Introduction to real-time systems, real-time scheduling, real-time synchronization, real-time operating system kernels, and real-time resource management algorithms (e.g., scheduling, synchronization), their implementations in production operating system kernels, experimental studies of those implementations, and real-time application development. Pre: 3574 or CS 3214. (3H,3C)

4554: INTRODUCTION TO COMPUTER VISION
Techniques for automated analysis of images and videos. Image formation, detecting features in images, segmenting or grouping image regions and image features, multiple view geometry, object instance and category recognition in images and video processing. Pre: 3574, (STAT 4705 or STAT 4714). (3H,3C)

4560: COMPUTER AND NETWORK SECURITY FUNDAMENTALS
This course introduces fundamental security principles and real-world applications of Internet and computer security. Topics covered in the course include legal and privacy issues, risk analysis, attack and intrusion detection concepts, system log analysis, intrusion detection and packet filtering techniques, computer security models, computer forensics, and distributed denial-of-service (DDoS) attacks. Must have C- or better in ECE 4564 or CS 3214. Pre: CS 3214 or ECE 2504. (3H,3C)

4564: NETWORK APPLICATION DESIGN
Application program interface and network transport services including User Datagram Protocol and Transmission Control Protocol from the Internet Protocol suite. Client-server organization and design of synchronous, asynchronous, and multithreaded client and server applications. Design, implementation, and testing techniques to improve robustness and performance. Partially duplicates CS 4254 and credit will not be allowed for both. Pre: (2504, 2574). (3H,3C)

4570 (CS 4570): WIRELESS NETWORKS AND MOBILE SYSTEMS
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects. Pre: 4564. (3H,3C)

4574: LARGE-SCALE SOFTWARE DEVELOPMENT FOR ENGINEERING SYSTEMS
Large-scale software implementations of the hierarchy of engineering analysis, design, and decision evaluation. Computer-aided engineering programs with state-of-the-art computer tools and methods. Operator overloading, dynamic polymorphism, graphical user interfaces, generic programming, dynamic link libraries, and multiple threads. Pre: 3574. (3H,3C)

4580: DIGITAL IMAGE PROCESSING
This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing focusing on the two major problems concerned with digital images: (1) image analysis and object restoration for easier interpretation of images, and (2) image analysis and object recognition. Some advanced image processing techniques (e.g., wavelet and multiresolution processing) will also be studied in this course. The primary goal of this course is to lay a solid foundation for students to study advanced image analysis topics such as computer vision systems, biomedical image analysis, and multimedia processing & retrieval. (3H,3C)

4584 (ME 4584): ROBOTICS LABORATORY
Develop, compile, and test algorithms for serial and mobile robots. Robot forward and inverse kinematics, task planning, velocity kinematics, force rendering, control, haptics, mapping and localization, computer vision and path planning. Co: ME 4524 or ECE 4704 (3L,1C)

4605-4606: RADIO ENGINEERING
Wireless application circuit design for gain and filter control at radio frequencies to interface the baseband processing systems and the antennas of communication systems. 4605: Design of radio transmitter and receiver circuits using scattering-parameter methods. Circuits include oscillators, radio frequency amplifiers and matching networks, mixers and detectors. 4606: Design of amplitude, frequency, and pulse-modulated communication systems, including modulators, detectors, and the effects of noise. Design basics and guidelines for phase-locked loops and several power amplifier configurations. Pre: 3105, 3204, 3614 for 4605; 4605 for 4606. (3H,3C)

4614: TELECOMMUNICATION NETWORKS
An introduction and overview of the architecture, technology, operation, and application of telecommunication networks. Major topics include the convergence of telephone and computer networks, the layered architecture of computer networks with emphasis on the Internet, and wireless network technology and applications. Pre: 2504, 2704, STAT 4714. (3H,3C)

4624: DIGITAL SIGNAL PROCESSING AND FILTER DESIGN
Analysis, design, and realization of digital filters. Discrete Fourier Transform algorithms, digital filter design procedures, coefficient quantization. Pre: C or better in 3704 Pre: 3704. (3H,3C)

4634: DIGITAL COMMUNICATIONS
System and signal level analysis and design for digital communications systems. Review of analog-to-digital conversion and digital baseband communications. Detailed analysis of digital carrier modulation formats including assessment of signal-to-noise ratio, bit error rate, and power and bandwidth efficiency for amplitude-shift keying (ASK), phase-shift keying (PSK), frequency-shift keying (FSK), and Quadrature-Amplitude Modulation (QAM). Matched filter receivers and receiver design, link budgets, and multiple access. Additive-white-noise Gaussian channels. A detailed discussion of random variables will be included to supplement prerequisite material. A C- or better is required in prerequisites. Pre: 3614. (3H,3C)

4644: SATELLITE COMMUNICATIONS
Theory and practice of satellite communications. Orbits and launchers, spacecraft, link budgets, modulation, coding, multiple access techniques, propagation effects, and earth terminals. Pre: 3614. (3H,3C)

4664: ANALOG & DIGITAL COMMUNICATIONS LABORATORY
Laboratory experiments which deal with the design and measurement of analog and digital communication systems. Concepts include SNR, Modulation Index, PCM, and spread spectrum. Pre: 3614. Co: 4634. (3L,1C)

4675-4676: RADIO ENGINEERING LABORATORY
Laboratory techniques for radio frequencies including the design of amplifiers, oscillators, and a single-side-band receiver. Associated measurements will be used. Pre: 3106, 3204 for 4675; 4675 for 4676. Co: 4605 for 4675; 4606 for 4676. (3L,1C)

4684: DIGITAL SIGNAL PROCESSING LABORATORY I
Introduction to modern-day networked technologies such as wireless, social, and economic networks. Analysis of networked technologies using analytical and engineering techniques such as optimization, game/auction theory, graph analysis, and learning as applied to networked technologies. Introduction to the basics of these techniques and their applications in networked systems. Development of a network science for solving practical problems pertaining to various networked systems such as smartphones, Wiki, Facebook, recommendation systems, economic network, or online video/music streaming software. Pre: 2704. (3C)

4704: PRINCIPLES OF ROBOTICS SYSTEMS
Introduction to the design, analysis, control, and operation of robotic mechanisms. Introduction to the use of homogeneous coordinates for kinematics, dynamics, and camera orientation; sensors and actuators, control, task planning, vision, and intelligence. II Pre: 2704 or (ME 3514, STAT 3704). (3H,3C)

4805-4806: SENIOR DESIGN PROJECT
Industry-like experience emphasizing technical, project management and personal development. Students working in teams will complete a sizeable hardware, or hardware related software project. Proposal process, design concept, detailed design, implementation and test. Important "real-life" skills such as teamwork, project management, communication, ethics and engineering professionalism. Two semester-long design project. Pre: 4805: Electrical Engineering majors must have completed the following courses with a C- or better: 2014, 2534, and any 2 of the following courses: (3105, 3204, 3304, 3614, 3704). Computer Engineering majors must have completed the following courses with a C- or better: 2014, 2534, 3574 and one of the following courses: (3204 and 3274, 3004 and 3074, 3544, 3614, 3704, 3714, 4424, 4704, CS 3214, CS 4264). 4806: A C- or better in prerequisite. Pre: 4805. (3H,3C)

4944: CYBERSECURITY SEMINAR
Theory and practice of cybersecurity problems and solutions for building secure computing hardware, software, and networks. Technical, social and legal aspects of secure systems. Historical and ongoing attacks that spawn real-world responses. Ongoing research in cybersecurity defenses. Senior standing. Pass/Fail only. Pre: 2504 or CS 2505. (1H,1C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
A minimum in-major GPA of 2.0 is required for enrollment. Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
A minimum in-major GPA of 2.5 is required for enrollment. Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
A minimum GPA of 2.0 in all ECE courses is required for enrollment. Variable credit course. X-grade allowed.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Economics

Chair: Sudipta Sarangi
Professors: R. Ashley, S. Ball, N. Bose, H. Haller, X. Lin, D. Salehi-Isfahani, S. Sarangi, A. Spanos, and T. N. Tideman
Associate Professors: E. Bahel, R. Cothren, A. Dominiak, S. Ge, K. Tsang
Assistant Professors: M. Fox, A. Habibnia, M. Kovach, S. Luo, M. Miller, B. Rosa, A. Smith, S. Trost, and G. Tserenijimid
Professor Emeritus: A. Mandelstamm and A. Kats
Instructors: G. Gebremariam
Undergraduate Advising/Career Advisor: E. Perdue (231-7726)

Web: **www.econ.vt.edu**

Overview

Specialization in economics prepares a person for a wide variety of careers that emphasize the methods and consequences of analytical decision-making in business and government and a broad understanding of the operation of the economy.

Economists are employed in private business and federal, state, and local governments. Economic analysis is directed at a wide range of problems including inflation and recession, environmental problems, taxation decisions, regulatory and antitrust problems, forecasting, and managerial decision-making. Undergraduate work in economics also provides an excellent background for further study in law,

political science, urban planning, and business administration.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Business Option

Science majors can declare a Business option which is designed to provide students an opportunity to explore introductory courses in traditional business subjects. It should be noted that this option is not a degree in the College of Business.

Minor Requirements

The requirements to earn a minor in economics can be found on its checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

5-Year B.A. / M.A.

The department offers a 5-year combined bachelor's and master's degree for students with a GPA of at least 3.5. See the undergraduate advisor for details.

Honors Degree

The department also offers an honors degree. See the undergraduate advisor for details.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.A. and B.S. in Economics can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (ECON)

1104: ECONOMICS OF GENDER
Economic approach to the causes and consequences of male/female gender differences in economic outcomes. Tools in microeconomic analysis and empirical work. Woman, family choices and labor markets. Gender gap in earnings. Employment and wage policies related to women. (3H,3C)

2005-2006: PRINCIPLES OF ECONOMICS
2005: Introduction to microeconomics. The economic approach to decision-making. Model of supply and demand. Elasticities. Consumer behavior. Firm behavior under varying industry structures. Sources and

consequences of market failure. Costs and benefits of international trade. The role of government in the economy. Economic, ethical, and social ramifications of issues such as pollution, missing information, and income inequality. 2006: Introduction to macroeconomics. The measurement of economic activity. Macroeconomic problems (such as unemployment and inflation). The monetary system. Effects and limitations of monetary and fiscal policies. International economics. Social and ethical issues related to macroeconomic policy. (3H,3C)

2025H,2026H: HONORS PRINCIPLES OF ECONOMICS
2025H: Microeconomics. Consumer behavior and demand, firm behavior and supply, price determination and market equilibrium under varying industry structure. Applications to labor and financial markets.
2026H: Macroeconomics. Measuring aggregate economic activity, macroeconomic problems (such as unemployment and inflation), the monetary system, effects and limitations of monetary and fiscal policies. (3H,3C)

2894 (PHIL 2894) (PSCI 2894): INTRODUCTION PHILOSOPHY, POLITICS, AND ECONOMICS
Integrated study of philosophy, politics, and economics. Trains students to make decisions that are not only economically sound, but also socially, ethically, and politically informed. Topics included: models of human nature, rational choice theory social cooperation, distributive justice, markets, and democracy. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

2994H: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

3004: CONTEMPORARY ECONOMIC ISSUES
The economic analysis of current issues and problems. This course may be repeated with different topic. Pre: 2006 or 2115 or 2125 or 2026H. (3H,3C)

3024: ECONOMIC JUSTICE
This course explores how different assumptions regarding the basis of claims for access to economic resources lead to different outcomes. Students will explore a variety of theories and examine their own beliefs about economic justice. Pre: (2005 or 2025H), (2006 or 2026H). (3H,3C)

3034: ECONOMICS OF POVERTY AND DISCRIMINATION
Poverty and inequality in the United States and around the world. Sources of poverty. Antipoverty policies. Definition, empirical evidence, and causes of discrimination. Emphasis on ethical human behavior and policy analysis. Pre: 2005. (3H,3C)

3104: MICROECONOMIC THEORY
Theories of demand, production, perfectly and imperfectly competitive price determination, and general market equilibrium. Analytic applications. Pre: Must complete ECON 2005 (with a C or better) and obtain (1) a C- or better in (MATH 1205, 1206, and 1114) or (MATH 1225, 1226, 1114) or (2) a B- or better in (MATH 1015, 1016, 2015) or (MATH 1525, 1525) or (MATH 1014, 1025, 1026) Pre: 2005, (MATH 1205, MATH 1206, MATH 1114) or (MATH 1015, MATH 1016, MATH 2015) or (MATH 1525, MATH 1526) or (MATH 1225, MATH 1226, MATH 1114) or (MATH 1014, MATH 1025, MATH 1026). (3H,3C)

3204: MACROECONOMIC THEORY
Theories of the determination of the level of aggregate economy-wide activity. Employment, the price

level, aggregate national income, and the interest rate. The roles of money and expectations. Pre: (2006 or 2026H), (3104 or 2025H), (MATH 1226 or MATH 1526 or MATH 1026). (3H,3C)

3214: MONEY AND BANKING
Money and credit. The U.S. monetary system. Monetary theory, monetary policy and economic stabilization. Pre: (2005 or 2025H), 2006. (3H,3C)

3254: ANALYSIS OF ECONOMIC DATA
Sources of economic data. Application of spreadsheet and/or statistical software to analysis of economic relationships using graphical and regression techniques. Emphasis is on economic applications rather than statistical theory. Pre: STAT 3005 or STAT 3604 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006 or BI T 2406. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4014: ENVIRONMENTAL ECONOMICS
Economic dimensions and aspects of programs designed to impose quality controls upon the environment. Special emphasis on problems of controlling air and water pollution. Pre: 2005 or 2116 or 2126 or 2025H. (3H,3C)

4044: PUBLIC ECONOMICS
Economic rationale of the public sector. Proper size and functions of government. Market failure, Cost-benefit analysis, public goods provision. Pricing of public enterprise services. Pre: 3104 or 2025H. (3H,3C)

4054: PUBLIC FINANCE
The structure and incidence of taxation in the U.S. Effects of taxes on incentives and economic efficiency. Tax Policy. Pre: 3104 or 2025H. (3H,3C)

4074: LABOR ECONOMICS
Human capital theory, labor supply and demand, discrimination, effects of labor unions and collective bargaining, wage differentials, income distribution. Pre: (2005 or 2116 or 2126 or 2025H), 3254. (3H,3C)

4084: INDUSTRY STRUCTURE
The structure and performance of American industry. Dimensions and measures of market structure. Factors affecting market structure. The relationship between structure and performance. Purpose and effects of antitrust policy, regulation, and other public policies toward industry. Pre: 3104 or 4924. (3H,3C)

4124: GROWTH AND DEVELOPMENT
Theories of economic growth. Policies to foster growth, and their consequences. Pre: 2006, (2025H or 3104). (3H,3C)

4135,4136 (AAEC 4135): INTERNATIONAL ECONOMICS
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid. Pre: 3104 or 2025H for 4135; 3204 or 4204H for 4136. (3H,3C)

4144: ECONOMICS OF CHINA
Evolution of the Chinese economy since 1949. Exposition of alternative economic systems, the commune, incentive problems, and state owned enterprises. Analysis of recent reforms and their effects on economic efficiency; and key issues of economic transition related to Russia and other East European countries. Pre: (3104 or 2025H). (3H,3C)

4214: ECONOMICS OF HEALTH CARE
Effects of medical care on health; cost and production of medical care; demand for medical care and its financing; structure of the health care industry; reorganization for efficiency. Pre: 2005 or 2025H. (3H,3C)

4304: INTRODUCTION TO ECONOMETRIC METHODS

An introduction to econometric modeling techniques, including regression methods. Particular emphasis on the special problems posed by economic data. Pre: STAT 3005 or STAT 3604 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006. Co: 3204, 3104. (3H,3C)

4404: ECONOMICS OF ORGANIZATIONS
Economic theories of organization, with specific attention to their internal structure, and to design of incentive systems. Application to mergers, to the relationship between stockholders and managers, etc. Students with one year of economics, calculus and major in some other social science, by permission of the instructor. Pre: 3104 or 4924 or 2025H. (3H,3C)

4424: THE THEORY OF GAMES AND ECONOMIC BEHAVIOR
Introduction to games and solution concepts, such as prisoner's dilemma, noncooperative equilibrium and Nash's bargaining solution. These concepts are applied in analyzing economic problems including bargaining problems, oligopoly and agency. Pre: 3104 or 4104H. (3H,3C)

4434: EXPERIMENTAL ECONOMICS
This is a course in the use of laboratory methods to study behavior in economics and the social sciences. Students will study state-of-the-art methodology in experimental economics, including experimental design, laboratory technique, financial incentives, and analysis of data. Students will participate in, design, and conduct experiments in bargaining, auctions, asset markets, public goods and commons situations, and risky decision-making. Pre: (3104 or 2025H), (BIT 2406 or MSCI 2406 or STAT 2004 or STAT 3005). (3H,3C)

4454 (NEUR 4454) (PSYC 4454): NEUROECONOMICS
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business. Pre: NEUR 2026 or ECON 3104. (3H,3C)

4754: INTERNSHIP
Qualified students are placed in an industry or government position under the combined supervision of a faculty member and a responsible supervisor in the employing agency. Satisfactory evaluation from employer, detailed reports on the internship experience and a specific project will be required of each intern. Pre: Junior standing, QCA of 2.50 or better and consent. Pass/Fail only. Variable credit course. X-grade allowed. Pre: 2005.

4884 (PHIL 4884) (PSCI 4884): ADVANCED TOPICS IN PHILOSOPHY, POLITICS, AND ECONOMICS
Advanced topics at the intersection of philosophy, politics, and economics. Core methods and concepts: utility theory, game theory, social choice theory, public choice theory, markets, justice, and democracy. Senior research project. Advanced Discourse. Pre: Senior standing. Pre: PHIL 2894 or PSCI 2894 or ECON 2894. (3H,3C)

4894: LAW AND ECONOMICS
Analysis of the economic effects of legal rules, with emphasis on the law of property, contract, liability, and land use. Pre: 2005. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

School of Education

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Associate Professors: A. P. Azano, N. E. Bodenhorn, B. R. Brand, W. J. Glenn, S. F. Hein, Y. Miyazaki, W. T. Price, T. T. Stewart, G. A. Tilley-Lubbs, C. L. Ulrich, L. E. Welfare, and T. O. Williams
Assistant Professors: B. D. Bowen, C. Catalano, M. C. Fullen, T. O. Grimes, F. Gu, T. B. Lane, and C. K. Robbins
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Collegiate Assistant Professors: J. S. Mukuni
Clinical Professors: C. S. Cash
Clinical Associate Professors: J. R. Gratto and B. Kreye
Clinical Assistant Professors: K. Potter and T. C. Sato
Assistant Professor of Practice: D. F. Fogelsong
Visiting Assistant Professors: A. L. Johnson, D. J. Kniola, and T. S. Price

Web: **www.soe.vt.edu**

Overview

The School of Education provides professional education programs and degrees only at the graduate level for professionals in Learning Sciences, prospective and experienced teachers, counselors, researchers, and leaders at the elementary, middle, secondary, and post-secondary levels. These programs prepare education professionals for varied employment settings. Special emphasis is placed on science, math, technology, and leadership. Advanced programs are offered at the master's, education specialist, and doctoral levels. To obtain specific information about these programs and their requirements, interested students should consult the Graduate Catalog or visit the School of Education's website (**www.soe.vt.edu**).

Entrance to the School of Education

Students enter education programs after completing a bachelor's degree with a major in a content field. Content fields vary depending on the teaching, counseling, or administrative license sought or other educational career goal of the student. There is a link to a listing of the appropriate undergraduate majors for teaching licensure in the Office of Academic Programs section of the School of Education website.

Licensure and Employment Opportunities

Students completing professional preparation programs are qualified to receive licenses in Virginia, and these licenses are also accepted in most other states. All degree programs are fully accredited by the Council for the Accreditation of Educator Preparation (CAEP) and the Virginia Department of Education. Graduates of professional preparation programs are well prepared for their initial responsibilities and are actively recruited by school systems across the state. Advisors counsel students early in their programs with respect to post-graduation placement opportunities.

Professional Preparation Programs Offered in the School of Education

The School of Education offers graduate professional preparation programs at both the initial and advanced levels. Please consult the Graduate Catalog (**www.graduateschool.vt.edu**) and the School of Education's website (**www.soe.vt.edu**) for admission and graduation requirements.

Undergraduate Course Descriptions (EDCI)

2614: THE READING MIND: LEARNING TO READ
Survey of theories and research that explain how people learn to read. Brief overview of English written systems. Models of skilled reading, literacy stages, and component processes (e.g., decoding, comprehension). Application of course concepts to self, common myths, media, and products. Analysis of patterns of inequity in reading achievement. (3H,3C)

2984: SPECIAL STUDY
Repeatable with different course content. Variable credit course.

3004: PRE-EDUCATION SEMINAR
Experiential learning in a PreK through 12th grade setting, public or private, exposing students to knowledge, skills, and dispositions of professional educators. Allows for integration of experiential and course-based learning in professional identity formation and exploration of education careers. NOT student teaching. May be repeated for elective credit up to a maximum of 12 credit hours. Can be used for a maximum of 3 Pathways credits. Pre: Junior standing. Variable credit course. X-grade allowed. 3024: ISSUES OF SCHOOLING IN THE UNITED STATES Exploration of U.S. education, purposes, and roles. Impacts of historic, social, political, economic, religious, cultural, global, and curricular issues. Analysis of equal educational opportunity. Role of the teaching profession in educational reforms. (3H,3C)

3144 (HD 3144): EDUCATION OF EXCEPTIONAL LEARNERS
Introduction to the historical, ethical, legal, and economic models relevant to understanding students with disabilities and meeting their needs to increase their potential for success throughout their lives. Addresses research in early intervention, K-12 instruction, post-secondary education, and transition into work settings. (3H,3C) (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4024: HUMANIZING THE K-12 CLASSROOM
Social, political, economic and historic structures maintaining power and privilege in the K-12 education system that disadvantage students of different racial, ethic, socioeconomic, class, and cultural groups. Classroom environmental design to support equity and social justice. Impact of teacher and student identity development on student learning. Twenty hours of experiential learning in educational setting. Pre: Junior Standing. (3H,3C)

4264: INTRO TO READING INSTRUCTION FOR ELEMENTARY STUDENTS: A CLINICAL COURSE
Overview of reading theory, terminology, and development in grade K-5. Introduction to reading assessment, text selection, lesson planning, and instructional strategies. Supervised clinical setting instructing K-5 learner. Pre: Junior or senior standing. (3H,3C)

4454 (ME 4454): ENGR. LEADERSHIP/MGMT
Introduction to management and mentoring skills associated with the application of the engineering design process. Course covers skills necessary for leading diverse teams of people through a technical design project. Managing teams of local high school students through an authentic technical design experience associated with design competitions. Course addresses the practical applications of science, math and engineering, while building and managing teams of people to meet technical project goals. Prerequisite: ME 4015 or similar team-based design experience, or by permission of instructor. (2H,3L,3C)

4984: SPECIAL STUDY
Repeatable with different content. Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

Undergraduate Course Descriptions (EDCO)

2004: HEALTHY RELATIONSHIPS: UNDERSTANDING SELF AND OTHERS
Basic concepts, skills, and theory associated with creating and sustaining healthy relationships in social and professional settings. Self-awareness as it relates to relationship-building. Characteristics and identities of self and others as they relate to relationship-building. Relationship-building skills such as active listening, perspective taking, and empathy. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

Undergraduate Course Descriptions (EDCT)

4754: INTERNSHIP IN EDUCATION
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Pre: Recommendation of program area and successful completion of Professional Studies requirement. Variable credit course. X-grade allowed.

4964: FIELD STUDY/PRACTICUM

Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

Undergraduate Course Descriptions (EDEP)

2444: MOTIVATING YOURSELF AND OTHERS
Survey of human motivation research and research methodologies in education, psychology, and neuroscience. Application of this research in diverse populations, including analysis of human motivation and design of motivating activities. (3H,3C) (3H,3C)

3154 (PSYC 3154): PSYCHOLOGICAL FOUNDATIONS OF EDUCATION
Emphasizes theories of human learning and the relationship of learning principles to educational practice in general. Within the context of cognitive, social, and behavioral models of learning, attention is given to instructional procedures, student motivation and discipline, and the assessment of educational progress. (3H,3C)

4984: SPECIAL STUDY
Variable credit course.

Undergraduate Course Descriptions (EDIT)

4614: INSTRUCTIONAL TECHNOLOGY: AUDIO-VISUAL AND COMPUTER USES
An introductory instructional technology course. Principles and production of audio-visual materials and methods in instruction. Application of microcomputers in instruction, emphasizing computer literacy, programming and evaluation of instructional software. Course in methods of teaching, field teaching experience, or teaching experience required. Pass/Fail only. (2H,3L,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (EDTE)

2964: FIELD STUDY/PRACTICUM
Variable credit course.

2984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4754 (ALS 4754): INTERNSHIP IN EDUCATION
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Recommendation of program area and successful completion of Professional Studies required. Variable credit course. X-grade allowed.

4964: FIELD STUDY/PRACTICUM
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
Variable credit course.

Engineering Education

Head: J.M. Case
Assistant Head for Undergraduate Programs: H.M. Matusovich
Assistant Head for Graduate Programs: D.B. Knight
Professors: J.M. Case, V.K. Lohani, L.D. McNair, M.C. Paretti, and B.A. Watford
Associate Professors: R.M. Goff, D.B. Knight, T.W. Knott, H.M. Matusovich, and K.J. Reid
Assistant Professors: D. Bairaktarova, J.R. Grohs, A.S. Katz, W.C. Lee, J. S. London, H. Murzi, and N.P. Pitterson
Assistant Professor of Practice: M.B. James
Associate Professor of Practice: W. M. Butler, B.S. Chambers, D.S. Gray, and N.C.T Van Tyne
Senior Instructor: J.L. Lo
Professor Emeritus: O.H. Griffin
Associate Professor Emeritus: T.D.L. Walker and M.H. Gregg
Academic and Career Advisors: J.J. Elmore, M. Greene-Havas, M.B. McGlothlin Lester, D.C. Newcomb, J.N. Newcomer, A. Noble, N.L. Smith, and A.N. Ward

Web: **www.enge.vt.edu**
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Overview

The Department of Engineering Education (ENGE) is home to all first-year and transfer engineering students. The department teaches the interdisciplinary first-year engineering courses, advises General Engineering (GE) students, and offers a graduate certificate and a Ph.D. in engineering education.

At the undergraduate level, the department provides the foundation for students to begin their engineering journey from their first semester until they complete a Bachelor of Science degree in one of the 14 College of Engineering programs. The department helps prepare students as they move into degree-related employment or graduate studies. At the graduate level, the department prepares scholars to advance knowledge and address significant challenges facing engineering education in careers including engineering faculty, policy makers, corporate training, university assessment and university administration.

Accreditation statements may be found in the listings for individual undergraduate degree programs.

Special Facilities

In addition to the Frith First-Year Design Laboratory described below, the department houses research laboratories that focus on generating cutting-edge research in engineering education and translating that research into practice to enhance undergraduate education. Undergraduate students are welcome to apply for research projects in these labs and centers. **https://enge.vt.edu/researchfacilties.html**

- The Frith First-Year Design Laboratory (Frith Lab) is a space designed to support the retention and development of first-year engineers through hands-on learning, peer mentoring, and authentic problem-solving. Part collaboration and innovation space, part fabrication and prototyping space, and part learning laboratory, the Frith Lab enables first-year engineering students to learn by analyzing, designing, and making engineering products. It features a Tensile/Compression Materials Testing machine, 3-D printers, laser engraver, CNC routers, and drill press, along with various hand tools. **https://enge.vt.edu/undergraduate/geexperience/frithlab.html**
- ACE(D) Lab - Through real-world engineering applications, the Abilities, Creativity, and Ethics in Design (ACE(D) Lab experiential learning research cross disciplines including engineering, psychology and the learning sciences, as they uncover how individual performance is influenced by abilities, personal interests and direct manipulation of physical and virtual objects. **http://aced.enge.vt.edu**
- ((EC)3 Lab - The (EC)3 Lab is a team of students and faculty committed to research, teaching, and

outreach within three interconnected areas. The first is Enacting Change - We are motivated by pressing challenges within the education system and broader society and we strive for positive change. The second is Embracing Complexities - We love wicked problems, coupled systems, socio-ethical complexities, and trying to make sense of all sorts of messy data. Our final interconnected area is Engaging Communities - We believe good things can happen when diverse stakeholders come together around shared goals. **https://enge.vt.edu/researchfacilties/(EC)3Lab.html**

- The VT DEEP Lab (Data Enlightened Educational Practice) strives to find ways to bring educational data into the conversation to guide decision-making processes for students, faculty, administrators, and policy makers. Our team takes a systems perspective of higher education whereby we consider a complex set of interrelated variables in investigating educational outcomes. Current projects include developing educational dashboards to illuminate broad patterns in learning data, investigating transfer students pathways into engineering, exploring shared leadership within student design teams using social network analysis, and exploring curricular, co-curricular, and organizational influences on the development of engineering students' learning outcomes. Team members have conducted research in both the U.S. and Australian higher education contexts. **https://enge.vt.edu/researchfacilties/Deeplab.html**
- The LabVIEW Enabled Watershed Assessment System (LEWAS) integrates hardware and software components to develop learning modules and opportunities for water sustainability education and research. LEWAS avails real-time water data using wireless technology from the Webb branch of Stroubles creek, an on-campus stream, for use in engineering courses. **http://www.lewas.centers.vt.edu/**
- The Virginia Tech Engineering Communication Center integrates the professional and the technical to create a new kind of engineer. VTECC brings faculty, students, and professionals together to explore, design, practice, and teach communication and collaboration in support of engineering work. Our lab provides a creative think space for engineering students and faculty to break through disciplinary molds and collaborate across boundaries to drive innovation. **www.vtecc.eng.vt.edu**
- The GUIDE Research Group is a unique and collaborative effort between engineering education researchers and student-support practitioners, directly bridging the research-to-practice cycle. Members of GUIDE (1) conduct practice-informed research, focused on identifying areas of opportunity within engineering education to advance inclusion and diversity; and (2) develop and evaluate research-based solutions for making engineering a more inclusive and diverse environment. Our vision of a more inclusive engineering community–locally, nationally, and globally–inspires our quest to answer the following questions: • How might we better support a diverse population of students? • How might we make engineering more inclusive? • How might we broaden participation in engineering? • How might we educate engineering students and faculty about diversity? **https://enge.vt.edu/researchfacilties/GUIDE.html**
- The Studies of Motivation and Identity in Learning Engineering (SMILE) group engages in research on and outreach to all levels of learners from pre-kindergarten through academic and industry workforces. We aim to inform, support, and create learning environments that encourage and enable broad participation in engineering majors and careers. We use motivation-and identity-related theories to examine ways to break down barriers, create opportunities, and engage all stakeholders (students, parents, teachers, co-workers) in thoughtful teaching and learning processes. **https://enge.vt.edu/researchfacilties/SMILE.html**
- The Research's Impact on Society and Education (RISE) Research Group is a diverse team of mixed methods researchers investigating the impact of research on society and education while simultaneously making an impact on STEM education through research. **http://impactfulresearch.com/**
- Wireless@vt.edu-The subgroup that Engineering Education is collaborating with works on the impact of serious games has on the teaching of wireless communication and the development and assessment of tutorials aimed to assist in the teaching and learning of spectrum sharing cognitive radios as well as hosing a Spectrum Sharing Competition each year. The work is facilitated by the CORNET radio network that is installed in Kelly Hall. **http://enge.vt.edu/researchfacilties/wireless.html**

First Year Students and General Engineering

The General Engineering (GE) program of the EngE department serves first-year students in the College of Engineering. Through EngE courses, first-year students participate in problem solving, engineering analysis and design exercises that represent the essence of the engineering profession. The courses emphasize team-based, design-oriented, hands-on experiences to develop students' concepts of engineering and engineering methods, while reinforcing the role of concurrent required courses (e.g. mathematics, English, physics). They also serve as a foundation for subsequent courses in the various engineering curricula. Coverage of engineering ethics instills a sense of the responsibilities of engineers to society. Algorithm development and computer programming develop logical thinking, provide the background for computer use in later courses, and support problem-solving skills. Spatial visualization skills are developed through engineering graphics, a primary engineering tool. Through writing and presentations, students begin to hone their professional communication skills, including audience analysis, visual rhetoric, effective writing styles, issues in collaborative writing, techniques of oral presentation, print and Web-based research, graphics for written and oral presentations, and editing.

All College of Engineering students must own 1) a convertible tablet PC or laptop running Windows 10 meeting current specifications, and 2) stipulated software used to analyze and solve problems in and out of class. Computer requirements for engineering students can be located at **www.eng.vt.edu/it/requirement**.

Process for Declaring a Degree-Granting Engineering Major

Entering students are admitted to General Engineering, the first-year program for all engineering curricula. The program introduces students to foundational concepts and practices in engineering, allows time to adjust to the College, and provides opportunities to investigate the College's individual degree programs and select the branch of engineering or computer science best suited to their skills and interests. At the end of the year - after academic advising, contacts with the various departments, and satisfactory progress - students select a degree program and, if academically eligible, are transferred to the appropriate degree-granting department.

Entry into a degree-granting engineering department requires that students successfully complete all required first-year courses. Students must also earn a minimum grade of C- in ENGE 1215 and 1216 before transferring into a degree-granting engineering department.

Please see the College of Engineering catalog section titled "Required Academic Progress" for details, and visit **https://enge.vt.edu/undergraduate/Undergraduate_changing_major.html** for application policies and dates.

Typical First Semester	
CHEM 1035: General Chemistry	(3)
CHEM 1045: General Chemistry Lab	(1)
ENGE 1215: Foundations of Engineering (C-)	(2)
ENGL 1105: First-Year Writing	(3)
MATH 1225: Calculus of a Single Variable	(4)
Typical Second Semester	
ENGE 1216: Foundations of Engineering (C-)	(2)
ENGL 1106: First-Year Writing	(3)
MATH 1226: Calculus of a Single Variable	(4)
PHYS 2305: Foundations of Physics I	(4)

Undergraduate Course Descriptions (ENGE)

1014: ENGINEERING SUCCESS SEMINAR
Introduction to opportunities and resources available to College of Engineering students during their undergraduate career at VT. Practice in information gathering skills critical for engineering students. Practice in oral, written, and visual communication. Preperation of an academic plan. Credit earned for this course may not be used to satisfy degree requirements. Co: 1215. (1H,1C)

1215-1216: FOUNDATIONS OF ENGINEERING
A first-year sequence to introduce general engineering students to the profession. 1215 (2 credit) data collection and analysis, engineering problem-solving, mathematical modeling, contemporary software tools, professional practices and expectations (e.g. effective communication, working in teams, ethics), and the diversity of fields and majors within engineering. 1216 (2 credits): data collection and analysis, engineering problem-solving, mathematical modeling, design, contemporary software tools, professional practices and expectations (e.g. communication, teamwork, ethics). All engineering majors require a grade of C- or better in 1215 and 1216 for transfer into the major. Each course can only be attempted twice, including attempts utilizing the W grade option. Design Lab/Studio (3L,2C)

1354: INTRO TO SPATIAL VISUALIZATION
Introduction to spatial visualization. Training to improve three-dimensional visualization skills. Does not count towards College of Engineering graduation credit. (1H,1C)

1414: FOUNDATIONS OF ENGINEERING PRACTICE
Introduction to engineering profession for transfer General Engineering students including engineering problem solving and design, contemporary software tools, and professional practices and expectations (e.g., communication, teamwork, ethics). All engineering majors require a grade of C- or better in 1414 for chance of major into the degree granting major. Duplicates 1215-16. Design Lab/Studio. (6L,4C)

1644: GLOBAL STEM PRACTICE: LEADERSHIP AND CULTURE
Develop global competencies in science, technology, engineering, and math (STEM) contexts and understand how problems and viable solutions vary across contexts and how intercultural communication and global leadership are important in an interconnected global workforce. Integrates semester-long on-campus module with international module following semester exams ("Rising Sophomore Abroad Program"). International module engages students in local culture during visits with STEM businesses and universities. Participation in both modules required. Enrollment by application. (3H,3C)

2094: CREATE!: IDEATION & INNOVATION
Apply problem solving framing strategies as part of problem solving design processes. Consider cultural, economic, social, and other perspectives in customer discovery and design processes in order to ensure problem/solution fit. Ideate possible solutions or approaches to address open- ended problems using a variety of methods. Engage in iterative critiques of strategies, solutions and prototypes using methods drawn from industrial design, engineering and the arts. Collaborate in interdisciplinary and diverse project teams. Communicate deliverables in multiple formats and for different audiences. Identify and address impacts of designed services and products through global perspectives, such as patterns of inclusion and exclusion and effects on localized ecosystems. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
I Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

4094 (IDS 4094) (MGT 4094): STARTUP: COMMERCIALIZATION OF INNOVATION
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a

representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback. (3H,3C)

4104: APPLIED EXPLORATIONS IN INNOVATION
Work in interdisciplinary teams to scope and plan an open-ended design project focused on technology commercialization that addresses a need or problem. Model systems and products computationally and quantitatively to address issues of technical and market feasibility and to predict performance under uncertain conditions. Engage in iterative design process that combines computational and quantitative processes with user-centered design and market analysis. Produce viable design that includes technical specifications, market evaluation, and customer discovery results. Communicate with wide range of audiences. Analyze ethical and intercultural and global impacts of innovation. Pre: 3 credits of foundational quantitative and computational thinking. Pre: STS 2254, ENGE 2094, (MGT 4094 or ENGE 4094 or IDS 4094). (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4974H: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

4994H: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

Menu

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English

Chair: Bernice Hausman
Associate Chair: Kelly Pender
Assistant Chair: Jennifer Mooney
University Distinguished Professor: N. Giovanni
Alumni Distinguished Professors: T. M. Gardner and L. H. Roy
Edward S. Diggs Professor in the Humanities: B. Hausman
Clifford A Cutchins III Chainr: Su Fang Ng
Professors: J. F. Eska, E. Falco, V. Fowler, C. Gemenez Smith, P. W. Graham, R. Hicok, K. Hodges, N. A. Metz, K. M. Powell, and D. H. Radcliffe
Associate Professors: S. Carter-Tod, G. Chandler-Smith, A. J. Colaianne, J. Dubinsky, C. M. Eska, P. Heilker, S. M. Knapp, J. Mann, E. Meitner, D. Mueller, S. F. Ng, K. Pender, K. Swenson, and J. M. Vollmer
Assistant Professors: K. N. Carmichael, K. Cleland, C. Commer, E. Lavender-Smith, C. Lindgren, A. Reed, J. Sano-Franchini, and A. J. Walker
Senior Instructors: R. Allnutt, M. Armstrong, M. Bliss, E. Bloomer, R. Canter, Z. K. Combiths, S. Frost, J. Harvill, A. F. Kinder, J. Lawrence, J. Mengert, J. Mooney, S. Mooney, M. D. Moore, A. Murphy, L. Neilan, S. Oakey, H. R. Patton, J. Scallorns, L. Skinner, G. Voros, and J. Wemhoener
Advanced Instructors: J. Barton, J. A. Gibbs, E. A. Lautenschlager, and V. Ruccolo
Instructors: H. Baker, S. Baker, C. Bean, S. Conaway, T. Gardner, R. Hooper, I. Johnson, M. Maycock, A. McGlone, and J. Truscello
Coordinator of Undergraduate Advising: Laura Ferguson (231-6515)

Web: **www.english.vt.edu**

Overview

The Department of English offers majors in English (study in literature, including pre-Law and pre-Education options), Professional and Technical Writing, and Creative Writing. A degree in English will appeal to students who are interested in a foundational education in the liberal arts, specializing in literature and writing, and who may pursue careers in business, government, education, law, speech sciences, writing, publishing, advertising, health, activism, the arts, or social services.

The Department of English also offers minors in Literature, Language Sciences, Professional and Technical Writing, and Creative Writing, and many of its courses provide credits for Pathways general education in Discourse, Critical Thinking in the Humanities, Critique and Practice in Design and the Arts, and Critical Analysis of Equity and Identity in the U.S.

English Degree Majors

Students working towards the B.A. in English may choose from three majors, each consisting of 39 required hours.

- A major in English
  Within the English major, there are three options available to students: Literature, Pre-Education, and Pre-Law.
- A major in Professional and Technical Writing.
- A major in Creative Writing.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

All three of the majors share a common English core that provides a foundational curriculum in research, critical thinking, and interpretation. Students in all three majors take these core courses together, providing a rich and diverse context for the study of writing and literature. The core requirements and specific major requirements can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education requirements (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in English.

Satisfactory progress requirements toward the B.A. in English can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Post Graduate Study

Undergraduate majors interested in pursuing advanced degrees (M.A., M.F.A., or Ph.D.) in English should, with the assistance of their professors, mentors, and the department's academic advisor, carefully plan their programs of study. Coverage across periods and genres is strongly recommended, as is a good reading knowledge of another language, for students planning to continue study for a master's or doctoral degree. Getting to know professors and learning as much as possible about the professional elements of the discipline provide excellent preparation for graduate work.

Pathways General Education and English

Pathways General Education requires a six hours of foundational Discourse credits and three hours of advanced or applied Discourse credits. English 1105 and 1106 fulfill the six foundational credits of this Pathways requirement. These courses share a focus on the rhetorical dimensions of writing, speaking, and visual communication. Many 2000-4000 level ENGL courses fulfill the advanced or applied Discourse credits, and can count toward students' majors and Pathways general education. The same is true of most courses that fulfill Critical Thinking in the Humanities, Reasoning in the Social Sciences, Critique and Practice in Design and the Arts, and Critical Analysis of Identity and Equity in the U.S.; courses that meet one or more of these requirements can count for Pathways and major credit.

Advanced Standing (AS): Some students are exempted from ENGL 1105 and granted Advanced Standing on the basis of three scores: SAT Critical Reading, SAT Writing, and Standardized High School Class Rank. Advanced Standing students fulfill their Freshman English requirement with ENGL 1106. If Advanced Standing students complete the assigned advanced course at Virginia Tech with a C- they receive pass/fail credit for ENGL 1105, the course from which they are exempted. Advanced Standing is a placement category for students at Virginia Tech; it is not related to the Advanced Placement (AP) courses offered in high schools or the AP exam offered by the Educational Testing Service (ETS).

Credit from AP, CLEP, and IB exams can fulfill the CLE Area 1 requirement. See "Advanced Placement," "Advanced Standing," and "International Baccalaureate" information in the Admissions section of this catalog.

Undergraduate Course Descriptions (ENGL)

0014: ORAL COMM INTERNATIONAL TAS
For international students taking regular academic loads. Practice in preparing and delivering oral reports in an academic field, as well as advanced pronunciation and aural comprehension exercises for effective classroom communication. Pass/Fail only. X-grade allowed. (3H,1C)

1004: BOOKS, LIBRARIES, ARCHIVES
First-Year Experience course that introduces students to primary objects and methods of inquiry and invention in English studies. Introduction to library and archival research, ethical inquiry, social and historical function of reading, role of books in society, technologies of publication and reading, and writing effective summaries and critical reflections. (3H,3C)

1105-1106: FIRST-YEAR WRITING
1105: Introduction to rhetorical analysis, visual rhetoric, critical writing, and critical thinking; intensive reading of works in multiple genres; practice in writing and revision; fundamentals of oral presentations.
1106: Continued study in rhetorical analysis and the conventions of various genres; intensive instruction in writing and revision of work that incorporates research; experience in oral presentations. (3H,3C)

1204H: HONORS FRESHMAN ENGLISH
Introduction to analytical, critical, and interpretive writing and reading at an advanced level and accelerated pace for students whose test scores and high school work indicate readiness for the Honors level of complexity, responsibility, and initiative; in a single semester, reviews the work of 1105 and focuses on the work of 1106 at the Honors level. Placement by the English Department required. (3H,3C)

1504: INTRODUCTION TO CONTEMPORARY LINGUISTICS
Introduction to the sounds of language, processes by which words and sentences are formed, how the

meanings of words are established by context, and why languages vary and change over time. (3H,3C)

1514: LANGUAGE AND SOCIETY
English language variation considered from social, regional, ethnic, gender, and style perspectives. Emphasis on vernacular varieties of American English. Attention paid to the social evolution of different language varieties and sociolinguistic perceptions of language ideologies. Introduction of methods of data analytics. (3H,3C)

1524 (PSYC 1524): LANGUAGE AND THE MIND
Examination of what is unique about human language and the evidence that language affects thought. Investigation of how listeners categorize sounds, parse sentences, and access meaning. Examination of what brain damage and speech errors reveal about language in the brain and mind. (3H,3C)

1604: INTRODUCTION TO POETRY
Examination of poetry across historical periods, cultural contexts, and geographical areas. Emphasis on poetic forms and conventions, elements of poetic technique, poetic genres, and the vocabulary of poetic craft. (3H,3C)

1614: INTRODUCTION TO SHORT FICTION
Analysis of short fiction and novellas from different historical periods and cultures. Emphasis on the structural elements of fiction, on its flexibility as a form for exploring human desires, conflicts, and values, and on its employment by writers from different cultures, ethnicities, and genders. (3H,3C)

1624: INTRODUCTION TO DETECTIVE FICTION
Analysis of classic and modern texts of detective fiction selected from a variety of historical periods and cultural traditions. Emphasis on the structural elements of detective fiction, on its various sub-genres, and on its employment by writers from different cultures, ethnicities, and genders. (3H,3C)

1634: INTRODUCTION TO SHAKESPEARE
Introduction to Shakespeare's drama and poetry, including at least one modern adaptation of a Shakespearean play (play, novel, movie, opera, etc.). Emphasis on the structural elements and conventions of the different genres of Shakespearean plays and poetry and on their representations of gender and ethnicity. (3H,3C)

1644: INTRODUCTION TO WORLD LITERATURE
World literature in translation. Texts from different time periods, nations, and cultures. Emphasis on close reading, literary elements and conventions, recurring themes, historical and cultural contexts. (3H,3C)

1654: INTRODUCTION TO SCIENCE FICTION AND FANTASY
Introduction of literary works within the genres of science fiction and fantasy, focusing on the development and principal characteristics of each genre. Emphasis on the social, cultural, and historical contexts in which particular speculative texts have been produced. (3H,3C)

1664: INTRODUCTION TO WOMEN'S LITERATURE
Introduction to literature written by women, primarily in English. Focus on literary and cultural questions raised in women's writing throughout history and from different social and cultural backgrounds. (3H,3C)

1704: THE HARRY POTTER PHENOMENON
Introduction to a millennial children's literature phenomenon, J.K. Rowling's seven-volume Harry Potter series, and to various critical and cultural responses to the books. Subgenres of fiction used in the series, such as the boarding-school novel and the sports novel; recurring themes in the series; critical concepts such as the Byronic hero and the anti-hero; the role of media in making the series an economic phenomenon; and the relationships of the novels to film versions and fan-fiction spin-offs. (3H,3C)

1EWL: WAITING LIST FOR ENGLISH 1105
(3H,3C)

1HWLH: WAIT LIST HONORS ENGLISH 1204
(3H,3C)

2034: ANALYZING THE SOUNDS OF LANGUAGE
Examination of the acoustic attributes of vowels and consonants using quantitative techniques. Statistical analysis of acoustical differences between and within speakers, enabling predictions about future language choices and outcomes. Basic introduction to using computational software for data processing and visualization, and to ethical issues that arise in collecting an analyzing data. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

2444 (CLA 2444) (RLCL 2444): ANCIENT GREEK AND ROMAN MYTHOLOGY
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English. (3H,3C)

2534: AMERICAN LITERARY HISTORY
Introduction to American literary traditions, from the Colonial period through Modernism. Emphases on historical, social, and cultural contexts as these are reflected by representative texts. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

2544: BRITISH LITERARY HISTORY
Introduction to British literary traditions, from the Anglo-Saxon period through Modernism. Emphasis on historical, social, and cultural contexts as these are reflected by representative texts. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

2604: INTRODUCTION TO CRITICAL READING
A writing intensive introduction to the techniques and theoretical implications of close reading and to the literary genres of poetry, drama, fiction, and, in some sections, non-fiction. The focus is on four primary texts, at least one of which was written before the eighteenth century and one after it, and on criticism of at least one of these. The course emphasizes the analytical skills, basic critical terminology, and conventions of literary criticism essential to advanced English studies. Intended primarily for English majors and minors. Pre: 1105 or COMM 1015. (3H,3C)

2624: READING AND WRITING ACROSS ENGLISH STUDIES
A variable topics, foundational course in the study and practice of reading and writing employed across disciplinary areas in English Studies. Introduction to rhetorical, creative, and professional modes. Writing intensive. Pre: 1106 or 1204H or COMM 2016. (3H,3C)

2634: WRITING AND SOCIAL JUSTICE
Study of writings about social justice in various local and global contexts. Critical and rhetorical analysis of discourses in social justice through intersectional approaches. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

2644 (AFST 2644): INTRODUCTION TO AFRICAN-AMERICAN LITERATURE
An introduction to the principal themes, genres, and historical contexts of African-American literature. Formal elements of both the vernacular and written traditions. Impact of historical and social contexts. Ethical questions raised in the literature. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

2744: INTRODUCTION TO CREATIVE WRITING
A workshop for beginning writers who will identify and apply formal elements of a variety of genres and employ the skills, tools, methods, and iterative processes used by creative writers to produce fully developed works of art. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

2804 (AINS 2804): CONTEMPORARY NATIVE AMERICAN LITERATURES
This course offers a sampling of fiction, poetry, and non-fiction by the most influential American Indian writers since 1970, authors such as Momaday, Silko, Deloria, Welch, Harjo, and Alexie. Students also learn about those aspects of cosmology and storytelling traditionally shared by all American Indian Nations, as well as about those aspects specific to the individual tribal traditions from which the authors

and their characters come. Pre: 1106 or H1204 or COMM 1016. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3024 (RLCL 3024): RELIGION AND LITERATURE
Read works from world literature, guided by selected critical readings. Compare/contrast diverse models of "religion" and "literature." Study how modernity has impacted traditions of religion and culture. Interpret literary texts that draw from multiple religions. Analyze religion-literature controversies in a range of social, cultural, political contexts. Synthesize sources of multiple media, formats, and contexts. (3H,3C)

3104: INTRODUCTION TO PROFESSIONAL WRITING
This course introduces students to the theory and practice of professional writing and its functions in workplace settings. In this rhetorically-based course, students gain experience with a variety of writing situations, composing documents that solve problems or help readers make decisions. Students learn current conventions and broadly applicable procedures for analyzing the audiences, purposes, and situations of professional writing, and learn strategies for adapting these conventions and procedures to meet the unique demands of each new situation and task. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3134 (WGS 3134): GENDER AND LINGUISTICS
Exploration of differences--real and imagined--in the speech of men and women, and the relationship between these differences to culture. Exploration of how language can reflect and reinforce gender inequality. Linguistic phenomena covered: pitch, vocabulary, sound change, language ideologies, and discourse strategies and types. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3144 (RLCL 3144) (SOC 3144): LANGUAGE AND ETHNICITY IN THE UNITED STATES
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3154: LITERATURE, MEDICINE, AND CULTURE
The representation of health and illness in literature and the cultural aspects of medicine as a practice. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3204: MEDIEVAL LITERATURE
This course presents medieval British literature from ca. 700 to 1500 in its representative modes and defining contexts, including the literary influences of pagan antiquity, the native British (Celtic) tradition, Scandinavian and contemporary continental influences, the Crusades, the Byzantine Empire, and the philosophical traditions of neoplatonism and scholasticism. Specific authors and texts will vary, but will include poetry, prose, and drama. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3214: RENAISSANCE LITERATURE
This course presents Renaissance British literature from 1500-1660 in its representative modes and defining contexts, including the discovery of the Copernican universe and the new world, the rise of Protestantism, the resultant Counter-reformation, the movement from humanism to empiricism, and the institution of Parliamentary democracy. Specific authors and texts will vary, but will include poetry, prose, and drama. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3224: LITERATURE OF THE ENLIGHTENMENT
Focus on Restoration and eighteenth-century British literature from 1660 to 1800, the period generally

recognized as the Enlightenment. Examination of the new resilience on reason and scientific method rather than superstition and tradition through the study of such writers as Bunyan, Swift, Dryden, and Johnson. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3234: ROMANTIC LITERATURE
This course presents Romantic literature from the late eighteenth century to 1832 in its representative modes and defining contexts, including the French, American, and Industrial Revolutions, the expansion of the British empire, the rise of the novel, Gothicism, and the intellectual influence of periodical essays. Specific authors and texts will vary, but will include poetry, fictional prose, and non-fictional prose. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3244: VICTORIAN LITERATURE
This course presents Victorian British Literature from 1832 to 1901 in its representative modes and defining contexts, including the development of modern science and the decline of traditional religion, the emergence of the mass reading public, and the glorification of the writer's role as prophet, guide, and culture critic. Specific authors and texts will vary, but will include poems, essays, plays, and novels. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3254: AMERICAN LITERATURE BEFORE 1900
This course presents American literature from before 1900 in its representative modes and defining contexts, including colonization, the founding of the republic, the Civil War, the settlement of the west, American Romanticism, and American Realism. Specific authors and texts will vary, but will include poetry and fictional and non-fictional prose. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3264: MODERNIST BRITISH LITERATURE
This course presents Modernist British literature from 1918-1945 in its representative modes and defining contexts, including World Wars I and II, the collapse of the British empire, the influence of Darwin, Marx, and Freud, and such literary movements as Modernism, Realism, and Stream of Consciousness. Specific authors and texts will vary, but will include poetry, prose, and drama. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3274: MODERNIST AMERICAN LITERATURE
This course presents Modernist American literature from 1918 to 1945 in its representative modes and defining contexts, including World Wars I and II, the Great Depression, and such literary movements as Modernism and Realism. Specific authors and texts will vary, but will include poetry, prose, and drama. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3304 (AINS 3304): THE LANGUAGES OF NATIVE AMERICA
Study of the structures of the native languages of the Americas; their interrelationships; their use in individual speech communities; contact with other languages; the interrelationships of linguistic structure, culture, and thought; their future survival. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3314: WORKING ENGLISH GRAMMAR
This course introduces students to the fundamentals of standard English written grammar. Some attention will also be paid to the use of English grammar for varying purposes. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3315-3316 (TA 3315-3316): PLAYWRITING
A workshop course in the craft and art of playwriting which emphasizes the development of craft and the nurturing of vision and art. 3315: primary focus is on the writing of original scripts with additional attention paid to the work of influential playwrights and critics. 3316: primary focus is on the creative process of developing a play with the collaborative influences of a director, actors, designers, and other theatre professionals. Consent of instructor required for 3316. Pre: 1106 or 1204H or COMM 1016 for 3315; 3315 for 3316. (3H,3C)

3324: ACTS OF INTERPRETATION
Foundational interpretive approaches in literary and rhetorical studies. Emphasis on broad frameworks and their implications for textual analysis. Pre: 2604. (3H,3C)

3364: TOPICS IN LITERATURE BY WOMEN
This rotating topics course examines literature written by women with different national and ethnic identities and from different historical periods. Specific content varies, but the common focus is on the fundamental issues surrounding women's writing, the critical methodologies commonly employed to analyze this writing, and the historical, social, and literary contexts influencing the particular writing being studied. May be repeated once with different content. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3414 (GER 3414): GERMAN LITERATURE IN ENGLISH
A variable content course devoted to the study of major German literary works in English translation. May be repeated with different content. May not be taken for credit toward a major or minor in a foreign language. No knowledge of German required. In English. One 2000 level English literature course required. (3H,3C)

3424 (RUS 3424): TOPICS IN RUSSIAN LITERATURE IN ENGLISH
Variable-content course devoted to the study of Russian literary classics. From general surveys of nineteenth- and twentieth-century literature to more intensive study of the works of a single major author. Aesthetic and rhetorical strategies. Interactions between literary movements and political, historical, and cultural events. May be repeated once with different content for a maximum of 6 credits. Readings and lectures in English. No knowledge of Russian required. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3434 (RUS 3434): THE WORKS OF VLADIMIR NABOKOV
Readings in major works of Vladimir Nabokov from the 1920s through the 1970s. Aesthetic and rhetorical strategies, literary analysis, major themes, immigration and cultural knowledge. Taught in English. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3514: ETHNIC LITERATURE FOR CHILDREN
This course examines the historical contexts of and issues surrounding ethnic literature for children. The course considers the literature in terms of aesthetics, cultural representations, and identity. Ethnic literatures considered may include Native American, African American, Asian American, and Latino/a. The course also introduces other ethnic literary traditions, such as world folk tales, that influence or parallel American ethnic children's books. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3524: LITERATURE FOR CHILDREN
General critical and historical survey of traditional and contemporary writing for children: picture books, folk literature, modern fantasy, poetry, drama, modern fiction, historical fiction. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3534: LITERATURE AND THE ENVIRONMENT
Study of fiction, poetry, and non-fiction that examine environmental issues, sustainability, and the relationship between the human and natural worlds within a local and global context. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3544 (CINE 3544): LITERATURE AND CINEMA
Works of literature and the films into which they have been transformed; emphasis on differences between media. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3584: THE BIBLE AS LITERATURE
This course focuses on the Bible both as a work of literature and as a major influence on the literatures of the world. Specific books of the Bible to be covered, as well as literary-critical approaches, will vary. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3614: SOUTHERN LITERATURE
The literature of the American South from 1840 to the present with emphasis on 20th-century fiction, drama, and poetry. Concentration on such writers as Faulkner, Capote, Chopin, Hughes, O'Connor, Welty, Walker, and others. Exploration of such themes as importance of land, family, community; roles of industry and agrarianism; race relations. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3624: APPALACHIAN LITERATURE
Appalachian writers from the 1800s to the present, including Murfree, Wolfe, and selected contemporary

authors. Course will treat artistic merit and such selected themes as the mountains, Appalachia as a frontier, ambivalence about the Civil War, religion, folk ways and traditions, coal mining, and cottage industries. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3644: THE POSTCOLONIAL NOVEL
A study of novels examining the historical, social, and cultural contexts before, during, and after colonization. Emphasis on major writers (e.g., Achebe, Coetzee, Roy, Phillips) across continents (Africa, Asia, North America) and the significant themes, tropes, and theories of the genre. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3654: ETHNIC AMERICAN LITERATURE
Variable content course which introduces major American ethnic literatures: African-American, Asian-American, Chicano/a, Arab-American, and Native American. Representative texts from one or two of these categories are examined within the cultural, historical, and geographical matrices within which they are written. May be repeated twice for credit if the content is different. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3684: LITERATURE AND THE LAW
This course introduces students to the representation of the law and lawyers in literature. Emphasis is placed on the cultural and historical contexts that shape our perception of the law and legal practice and on the use of facts, research, interpretation, and rhetoric in legal argument. Junior standing required. (3H,3C)

3684H: LITERATURE AND THE LAW
This course introduces students to the representation of the law and lawyers in literature. Emphasis is placed on the cultural and historical contexts that shape our perception of the law and legal practice and on the use of facts, research, interpretation, and rhetoric in legal argument. Junior standing required. (3H,3C)

3694: TOPICS IN WORLD NOVELS
Rotating-topics course in world novels, either translated into, or originally written in, English. Emphasis on critical reading of novels written from different cultural contexts. May be repeated once with different topics. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3704: CREATIVE WRITING: FICTION
This course is designed for students who want to focus in some depth on the writing of various forms of fiction such as the short story and novella. Emphasis is on the writing the critiquing of original fiction in a workshop/studio environment, and the analysis of exemplary texts which serve as models. Students produce a body of original fiction in draft and revised forms. May be repeated for a maximum of 9 credit hours. Pre: 2744. (3H,3C)

3714: CREATIVE WRITING: POETRY
This course is designed for students who want to focus in some depth on the writing of poetry. Emphasis is on the writing and critiquing of original poetry in a workshop/studio environment, and the analysis of exemplary poems which serve as models. Students analyze various poetic forms and produce a revised body of original poetry. May be repeated for a maximum of 9 credit hours. Pre: 2744. (3H,3C)

3724: CREATIVE WRITING: CREATIVE NON-FICTION
This course is designed for students who want to focus in some depth on the writing of creative non-fiction in its various forms, including memoir, personal experience writing, the lyrical essay, travel narratives, and nature writing. Emphasis is on the writing and critiquing of original creative non-fiction in a workshop/studio, environment and the analysis of exemplary texts which serve as models. Students produce a body of original non-fiction in draft and revised forms. May be repeated for a maximum of 9 credit hours. Pre: 2744. (3H,3C)

3734: COMMUNITY WRITING
Introduction to the theory and practice of managing service- learning writing projects in schools, community centers, retirement communities, and public libraries. Survey of best practices in creative

writing pedagogy and in creating sustainable community partnerships. Pre: 2744. (3H,3C)

3734H: COMMUNITY WRITING
Introduction to the theory and practice of managing service- learning writing projects in schools, community centers, retirement communities, and public libraries. Survey of best practices in creative writing pedagogy and in creating sustainable community partnerships. Pre: 2744. (3H,3C)

3744: WRITING CENTER THEORY & PRACTICE
Focus on the theory and practice of teaching writing across the disciplines in the Writing Center setting. Emphasis is on writing center theory applied to one-on-one teaching strategies and on techniques for responding appropriately to student writing. To take this course you must first have the professor's consent. (3H,3C)

3744H: WRITING CENTER THEORY AND PRACTICE
Focus on the theory and practice of teaching writing across the disciplines in the Writing Center setting. Emphasis is on writing center theory applied to one-on-one teaching strategies and on techniques for responding appropriately to student writing. To take this course you must first have the professor's contest. (3H,3C)

3754: ADVANCED COMPOSITION
Advanced training in writing analytical and critical essays. Practice in addressing a range of audiences and in using varied styles and organizational patterns. Workshop and conference for students in arts and humanities, as well as for technical and extension students who wish to address non-specialized audiences and to practice forms outside their own fields. Junior standing required. (3H,3C)

3764: TECHNICAL WRITING
Principles and processes of effective written communication of technical information. Strategies for analyzing various workplace communication situations, adapting to audiences, evaluating online content, understanding ethical dimensions of research, and composing technical discourse, including organizing visual and verbal information. Practice in writing, individually and collaboratively, instructions and procedures, proposals and reports, correspondence, and presentations. Junior standing. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3774: BUSINESS WRITING
Extensive practice in forms of persuasive and informative writing such as memos, case analyses, reports, abstracts, and letters. Designed for students in all curricula. Junior standing required. (3H,3C)

3804: TECHNICAL EDITING AND STYLE
Technical Editing and Style explores the art of editing from the initial writing task to the final delivery of the document. In addition to learning document management, students study and practice the roles, responsibilities, and tasks that editors perform. The course also covers the rules that govern the fundamentals of style (correctness, clarity, and propriety) and the principles needed to match the tone and formality to the aim, audience, and occasion of the work. Must have pre-requisites or the consent of the Director of Professional Writing. Pre: 1106 or 1204 or 1204H or COMM 1016. (3H,3C)

3814: CREATING USER DOCUMENTATION
This course prepares students to produce both print and online user documentation that enables people to accomplish a given set of tasks (e.g., user guides, online help, policy and procedure manuals, tutorials, and how-to books). Readings include rhetorical theory and discussions of professional practice. Students learn the principles of user and task analysis, information design, usability testing, and indexing. In addition, they have opportunities for hands-on experience with clients and end-users. Must have pre-requisites or the consent of the Director of Professional Writing. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3824: DESIGNING DOCUMENTS FOR PRINT
This course prepares students to design and produce complex documents such as proposals, brochures, booklets, and newsletters using computer technologies. Students learn rhetorical and visual factors (e.g., legibility, readability, layout, and integration of text/images) that contribute to the effectiveness and

usability of documents. In addition, students study the use of color and electronic image editing. They also master some of the technologies necessary to publish documents from their desktops. In addition to working on individual projects, students engage in collaborative exercises intended to sharpen their teamwork, editing, writing, audience- awareness, and design skills. Must have prerequisite or consent of the Director of Professional Writing. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3834: INTERCULTURAL ISSUES IN PROFESSIONAL WRITING
Focuses on intercultural and international issues in the global workplace. Explores, through examination of theoretical perspectives and practical applications, ways in which notions about culture and national identity shape professional interactions. Provides a foundational understanding of the issues involved in writing and designing documents for international audiences. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3844: WRITING AND DIGITAL MEDIA
Introduction of the fundamental practices and emerging theories of writing with, and for, digital media. Basic authoring in web development syntaxes, critical interpretation of online sources, social media management, and topics of computational abstraction for writers. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4004: LINGUISTIC DISCOURSE ANALYSIS
Introduction to discourse analysis. This course examines spoken and written discourses of English. Further attention will be paid to how discourse functions in political, legal, medical, and educational contexts. (3H,3C)

4054: HISTORY OF THE ENGLISH LANGUAGE
Development of English including both its internal history (sounds, vocabulary, inflections, syntax) and its external history (political, social, and intellectual forces). Indo-European origins through the present, with special emphasis on the English Language in America. (3H,3C)

4074: SYNTAX
Examination of the systemic organization of sentence patterns in human languages. Formulation of problems and evaluation of competing syntatic analyses at the phrase and sentence levels. Analysis of the architecture of phases and of movement processes for grammatical and pragmatic informational coding. Pre: 1504. (3H,3C)

4084: CONDUCTING RESEARCH IN THE LANGUAGE SCIENCES
Research methodology for the study of linguistic structure, sociolinguistic variation, and cross-field approaches. Ethical research methods, data collection, data processing and analysis, presentation of research. Pre: 1504, (3134 or WGS 3134 or ENGL 3144 or RLCL 3144 or SOC 3144). Co: 4144, 4074. (3H,3C)

4114: CHAUCER
This course examines the life, work, and critical reception of Geoffrey Chaucer. Junior standing required. (3H,3C)

4124: INTRODUCTION TO OLD ENGLISH Introduction to Old English grammar and reading of Old English poetry and prose. Senior standing required. (3H,3C)

4134 (PSYC 4134): LANGUAGE DEVELOPMENT
Survey of theories, mechanisms, and processes in human language development. Empirical overview of phonology, semantics, syntax, and pragmatics. Developmental trajectories of mono-and multilingual children. Cultural constraints on language. Perception of language and production of language, in typical and atypical subpopulations (e.g., hearing impairment). Junior/Senior Standing. Pre: PSYC 1004 or PSYC

2004. (3H,3C)

4144: PHONOLOGY
Examination of the systematic organization of sounds in human languages based upon problem-based learning. Analysis of syllables and morae, articulatory features, timing of articulatory gestures, and phonological processes that lead to sound change. Assessment of various theoretical and computational approaches to phonology including Articulatory Phonology, Prosodic Phonology, and Optimality Theory. Pre: 1504. (3H,3C)

4164: STUDIES IN SHAKESPEARE
Revolving topics in Shakespeare's drama and poetry, with emphases on poetic and dramatic genres, historical and cultural contexts, significant themes, and popular reception. Additional attention paid to the critical discourse surrounding Shakespeare's work. May be repeated twice with different content for a maximum of nine credit hours. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4214: MILTON
Milton's poetry from the early works, including COMUS, LYCIDAS, and the sonnets, to his major late works PARADISE LOST, PARADISE REGAINED, and SAMSON AGONISTES; with some attention to the important prose and to the historical context in which he wrote. (3H,3C)

4314 (STS 4314): NARRATIVE MEDICINE
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4314H (STS 4314): NARRATIVE MEDICINE
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics. Pre: 3154 or 3324. (3H,3C)

4434: THE AMERICAN NOVEL
Development of the American novel from its beginnings in the late 18th century to 20th century postmodernism. Emphasis on works representative of major authors (e.g., Twain and Morrison), important types (e.g., the romantic novel, the historical novel), and significant American themes (e.g., religion, nature, slavery, the frontier). Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4444: THE BRITISH NOVEL
Development of the British Novel from the mid- eighteenth century to World War II, including works by such novelists as Defoe and Austen (origins through romantic era), Dickens, Hardy, and Stevenson (Victorian and Edwardian era), Joyce, Woolf, and Waugh (modern period). Emphasis on evolution of generic styles and conventions against a changing landscape of historical and cultural change. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4504: MODERN POETRY
British and American poetry from 1900 to World War II with emphasis on such figures as Pound, Williams, Stevens, Yeats, Plath, Smith, and Eliot. (3H,3C)

4514: CONTEMPORARY POETRY
British and American poetry from World War II to the present, with emphasis on such figures as Bishop, Lowell, Ashbery, Heaney, and Hughes. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4624: STUDIES IN A BRITISH AUTHOR AFTER 1800
This course examines the life, work, and critical reception of a single major British author (or pair of closely associated authors) writing after 1800. May be taken up to 3 times with different content. Junior standing required. (3H,3C)

4634: STUDIES IN AN AMERICAN AUTHOR BEFORE 1900
This course examines the life, work, and critical reception of a single major American author (or a pair of closely associated authors) writing before 1900. May be taken up to three times with different content.

Junior standing is required. (3H,3C)

4644: STUDIES IN AN AMERICAN AUTHOR AFTER 1900
This course examines the life, work, and critical reception of a single major American author (or pair of closely associated authors) writing after 1900. May be taken up to three times with different content. Junior standing is required. (3H,3C)

4664: CONTEMPORARY FICTION
Fiction since 1945 with emphasis upon the most recent two decades: the late modernist narratives of Bellow, Updike, and Percy; the new fiction of Barth, Hawkes, Barthelme; the postmodern fiction of Federman, Carter, Fowles, Katz, Sukenick. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4674: STUDIES IN CONTEMPORARY CULTURE
Studies the emerging changes across arts media (including architecture, cyberculture, essay, fiction, film, painting, performance, photography, poetry, theatre, video) in relation to current cultural and social theory from a variety of disciplines (including architectural theory, art, history, literature, philosophy, psychoanalysis, and social sciences). (3H,3C)

4684: SPECIAL TOPICS IN LITERATURE
An advanced, variable-content course which explores a significant or emergent literary issue or approach, or a body of literature. May be taken twice with different content. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4704: ADVANCED CREATIVE WRITING: FICTION
Designed for senior English majors who have selected the Creative Writing option, this is an intensive, advanced workshop. This capstone course builds on skills students have acquired in creative writing workshops. Primary focus is on the writing and critiquing of original fiction, while paying close attention to the work of established writers who are acknowledged masters of their genres. Students hone their skills as peer reviewers and constructive critics. In the process, they produce a portfolio of their own fiction. Pre: 3704. (3H,3C)

4714: ADVANCED CREATIVE WRITING: POETRY
Designed for senior English majors who have selected the Creative Writing option, this is an intensive, advanced workshop. This capstone course builds on the skills acquired in previous creative writing workshops. Primary focus is on the writing and critiquing of original poems, while paying close attention to the work of established poets who are acknowledged masters of their genres. Students hone their skills as peer reviewers and constructive critics. In the process, they produce a portfolio of their own poetry. Pre: 3714. (3H,3C)

4724: CREATIVE WRITING: FICTION FOR YOUNG PEOPLE
This course is conducted in a workshop setting in which students compose original stories for young people. Elementary techniques of fiction are emphasized, such as plot structure, point of view, setting, characterization, and audience. Must have prerequisites or permission of the instructor. Pre: 3704. (3H,3C)

4784: SENIOR SEMINAR
Designed for senior English majors, this is a variable topics, in-depth study of a particular issue or theme in language or literature. This capstone course aims to integrate and synthesize previous work in the discipline, focusing especially on close reading, research, and writing skills. Pre: 1106. (3H,3C)

4804: GRANT PROPOSALS AND REPORTS
This course prepares students to write effective proposals, reports, and informational articles. Students learn to define and write problem statements, program objectives, plans of action, evaluation plans, budget presentations, and summaries. In addition, they sharpen their teamwork, editing, writing, audience awareness, and design skills as they engage in collaborative projects with campus and/or non-profit organizations in the community. Prerequisite or consent of the instructor is required. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4814: DEVELOPING ONLINE CONTENT

Covers the process of creating documents for online environments. Builds on knowledge and skills acquired in foundational Professional Writing courses. Involves production of websites from scratch, starting with low-fidelity mockups and advancing to formatting layouts adaptable to the diverse screen sizes of computers and mobile devices. Focuses on a balance of structure (code), content (information), and format (presentation and design). Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4824: SCIENCE WRITING
Writing in and about the natural and social sciences. Students will write documents such as abstracts, research proposals, and ethnographies, analyze the development of disciplinary writing practices, and study non-fiction science writing for general audiences. Senior standing or instructor approval required. Pre: 1106 or 1204H or COMM 1016. (3H,3C)

4854: WRITING, RESEARCH, STUDY ABROAD
Application of academic abroad experience to student's disciplinary studies on campus. Conducted after international education abroad experience. Collaborative writing and research projects as well as individual, independent research. Approval of course instructor required. Open to all majors. Pre-requisite: A formal study abroad educational experience; department approval. (3H,3C)

4874: ISSUES IN PROFESSIONAL AND PUBLIC DISCOURSE
In this course designed for English majors in the Professional Writing Option, students will focus on the ways in which scientific, technical, and professional communication influence, and are influenced by, public discourse. Drawing on strategies of rhetorical criticism, students will gain an understanding of the persuasive value of style, arrangement, and delivery by investigating their professional roles in helping to structure public debate. Pre: Completion of at least 9 credit hours from the following courses: 3104, 3804, 3814, 3824, 3834, 4804, 4814, 4824. Pre: 3104. (3H,3C)

4954: STUDY ABROAD: ISSUES AND TEXTS
An advanced, variable-content and multi-disciplinary course that explores global themes and literature(s) during a month-long, faculty-led summer study abroad experience. Pre-requisite: Junior Standing required. Variable credit course, repeatable up to 6 credits. Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Non Degree Engineering Courses

Overview

The following courses are applicable to study in several departments and do not carry departmental designations. Several of the undergraduate courses listed below were developed specifically for students in both engineering and non-engineering majors with the objective of broadening the base of knowledge in cross-disciplinary areas with some background within a technology driven focus. Others were created as partof the academic, professional and personal support services provided for engineering students. Most students will use these courses to satisfy free electives in their programs. Engineering students also may find these courses of value in broadening their perspectives regarding their fields of study and may wish to use them as free electives in their programs.

Undergraduate Course Descriptions (ENGR)

1014: ENGINEERING RESEARCH SEMINAR
Discussion of current research topics in the College of Engineering by Virginia Tech Faculty. (1C, 1H) Pass/Fail only. (1H,1C)

1034: FIRST YEAR HYPATIA SEMINAR
Success strategies that are designed for first-year female engineering students who are residents of the Hypatia learning community are presented. Students are provided information on study skills; resources and academic support for Virginia Tech students; gender issues in engineering; service learning; leadership; technology; and the College of Engineering’s departments/majors. (2H,2C)

1054: FIRST YEAR GALILEO SEMINAR
Success strategies that are designed for first-year male engineering students who are residents of the Galileo learning community are presented. Students are provided information on study skills; resources and academic support for Virginia Tech students; gender issues in engineering; service learning; leadership; technology; and the College of Engineering’s department/majors. (2H, 2C) (2H,2C)

1814: ENERGY, RESOURCE DEVELOPMENT AND THE ENVIRONMENT
Population trends. Renewable and non-renewable energy. Coal mining methods, reclamation of mined lands.

Petroleum and natural gas. Nuclear waste. Land management, aquifer depletion. Development of mineral reserves, surface and underground mining, environmental impacts. Minerals in world economics. Geopolitical concerns. Global environmental effects of industrial enterprises. Sustainable development. Effects of social structures. Regulatory processes and national/international legislation. (3H,3C)

2004A: ENGINEERING INTERNATIONAL ACTIVITY
Engineering International Education course reflects academic effort in study abroad settings as defined by the college. No degree applicable credit awarded. Enrollment in this course does not apply toward the definition of full time status. 0 Credits. (0C)

2004E: ENGINEERING EXPERIENTIAL LEARNING
Engineering Experiential course reflects college defined experiential learning experiences for undergraduates. No degree applicable credit is awarded. Enrollment in this course does not apply toward the definition of full time status. (0C)

2004R: ENGINEERING UNDERGRADUATE EXPLORATORY ACTIVITY
Engineering Undergraduate Exploratory Activity course is an undergraduate research experience as defined by the college. No degree applicable credit is awarded. Enrollment in this course will not apply toward the definition of full time status. 0 Credits. (0C)

2004S: ENGINEERING SERVICE LEARNING
Engineering Service Learning course reflects academic effort in service learning settings as defined by the college. No degree applicable credit is awarded. Enrollment in this course will not apply toward the definition of full time status. 0 Credits. (0C)

2044: SECOND YEAR HYPATIA SEMINAR
Success strategies designed for second year women engineering students who are participants of Hypatia, the women in engineering residential community; topics include women in the engineering workplace, leadership, and goals associated with academic and professional success. (1H,1C)

2064: GALILEO SEMINAR FOR SOPHOMORES
This course is designed to assist sophomore students who are participants of Galileo, an engineering learning community in their efforts to become/remain successful students at Virginia Tech. The course will include focus on issues regarding the workplace, leadership, and goals associated with academic and professional success. Prerequisite: ENGR 1054 (1H, 1C) Pre: 1054. (1H,1C)

2164 (COS 2164): INTRODUCTION TO SCIENEERING
Seminar-based course providing a survey of current interdisciplinary science and engineering research problems; introduction interdisciplinary thinking and communication; issues related to interdisciplinary research teams. (1H,1C)

2174: PRINCIPLES OF COMPUTER SYSTEMS
This course is designed to give students an introduction to the software behind computer system security basics, including: a Unix/Linux operating system, Assembly/C++/Python coding, networking, and network security. This course is intended for non-ENGR majors. (3H,3C)

2464: ENGINEERING FUNDAMENTALS FOR SCIENTISTS
Introduction to the engineering profession and basic engineering skills for students pursuing science majors. Fundamentals of graphing, technical communication, ethics, the design process, project management, and problem solving as applicable to engineering. Partially duplicates ENGE 1024. May not be used for credit towards any degree from the College of Engineering. Pre: 2164 or COS 2164. (2H,2C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH

Variable credit course.

3124: INTRODUCTION TO GREEN ENGINEERING
Introduction to green engineering and global environmental issues. Impacts of human and engineering activities on the environment, and techniques that can be utilized to minimize adverse environmental impacts with emphasis on environmentally conscious design and manufacturing. Pre: (CHEM 1035 or CHEM 1074), (ENGE 1216 or ENGE 1104 or ENGE 1114), PHYS 2306. (3H,3C) 3984: SPECIAL STUDY Variable credit course.

4064 (COS 4064): SCIENEERING CAPSTONE
A capstone experience centered around an open-ended, faculty-advised senior project involving the design of a process, material, or technique for solving an interdisciplinary problem. Pre: Enrollment in Interdisciplinary Engineering and Science Minor. Pre: 2464 or BIOL 2124. (3H,3C)

4134: ENVIRONMENTAL LIFE CYCLE ASSESSMENT
Quantification of the environmental impacts for products, processes, and systems across all engineering disciplines. A detailed look at life cycle phases and formal and informal Life Cycle Assessment (LCA) methodologies including ISO standards, stream-lined LCA, green building ratings systems, carbon footprints, and other environmental ratings systems. Pre: 3124. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Environmental Science

Head: Michael Evans
Undergraduate Program Director: M. J. Eick (231-8943; eick@vt.edu)

Web: **www.cses.vt.edu/undergraduate-programs/ensc/index.html**

Overview

This program brings the basic sciences to bear on many crucial concerns about the environment. The environments of particular interest are terrestrial and wetland ecosystems and associated land and water resources. Specific concerns include environmental protection, pollution prevention and remediation, land-use planning, waste management, ground- and surface-water quality, reclamation and remediation of disturbed or contaminated sites, and minimizing human impacts on the environment.

The Environmental Science curriculum is multidisciplinary and strongly science and technology oriented. The curriculum prepares graduates for immediate entry into environmental careers as well as for graduate specializations. The U.S. Bureau of Labor Statistics forecasts that employment of environmental scientists and specialists is projected to grow 11 percent from 2014 to 2024, faster than the average for all occupations.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Requirements for a Minor

The Environmental Science program also offers a minor. The requirements include CSES/ENSC 3114 plus 3124 (or CSES/ENSC 3134) and CSES/ENSC 3604 and 14 to 15 more hours selected from a set of 23 courses. See **www.cses.vt.edu/undergraduate-programs/ensc/index.html** or visit 240 Smyth Hall for more information about a minor in environmental science.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Opportunities to Excel

Students with outstanding records can qualify for the Honors Program and graduate "in honors" in environmental science. Other opportunities for personal and professional growth and for recognition include the department-sponsored Environmental Student Organization, membership in Alpha Zeta and other honoraries, and several scholarships designated for majors. Faculty members often offer undergraduates opportunities to become involved in a variety of environmental research projects. Many employers seek environmental science majors for internship and co-op positions.

Undergraduate Course Descriptions (ENSC)

1015-1016: FOUNDATIONS OF ENVIRONMENTAL SCIENCE
Interrelationships between human activities and the environment; emphasis on biological, chemical, and physical principles that govern the flow of energy, materials, and information among physical, ecological and human systems. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3114 (CSES 3114) (GEOS 3614): SOILS
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and

biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant- and earth-science majors. Partially duplicates 3134. Junior standing. Pre: CHEM 1036. Co: 3124. (3H,3C)

3124 (CSES 3124) (GEOS 3624): SOILS LABORATORY
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134. Co: 3114. (3L,1C)

3134 (CSES 3134): SOILS IN THE LANDSCAPE
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS. (2H,3L,3C)

3604: FUNDAMENTALS OF ENVIRONMENTAL SCIENCE
Interrelationships between human activities and the environment; provides national and global perspective; emphasis is on the physical, chemical, and biological principles and processes that are essential to an understanding of human-environment interactions; the role of energy in human and natural systems; environmental legislation and human behavior. Pre: BIOL 1105 or CHEM 1035. (3H,3C)

3614 (CSES 3614): SOIL PHYSICAL AND HYDROLOGICAL PROPERTIES
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance. Pre: (CSES 3114, CSES 3124) or (GEOS 3614, GEOS 3624). (3H,3C)

3634 (CSES 3634): PHYSICS OF POLLUTION
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils. Pre: CSES 3114, PHYS 2206, (MATH 2016 or MATH 2024). (3H,3C)

3644 (CSES 3644): PLANT MATERIALS FOR ENVIRONMENTAL RESTORATION
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils. Pre: BIOL 1106. Co: CSES 3114. (3H,3C)

4134 (CSES 4134): SOIL GENESIS AND CLASSIFICATION
Formation of soils across landscape, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory. Pre: (CSES 3114, CSES 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (3H,3C)

4164 (BIOL 4164) (CSES 4164): ENVIRONMENTAL MICROBIOLOGY
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling. Pre: BIOL 2604. (2H,3L,3C)

4314 (CSES 4314): WATER QUALITY
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors

affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies. (3H,3C)

4324 (CSES 4324): WATER QUALITY LABORATORY
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314. Pre: CHEM 1046. Co: CSES 4314, 4314. (3L,1C)

4414: MONITORING AND ANALYSIS OF THE ENVIRONMENT
Provides comprehensive hands-on-laboratory-and field-based experience and information on the principles and methods for field monitoring and sampling, as well the physical, chemical, and biological analysis of soil, surface water, groundwater, and solid wastes within the context of regulatory compliance. Optional 40-hour Hazards Materials (HAZMAT) training will be available. Senior standing required. Pre: (3604 or 4314 or CSES 4314 or BIOL 4004), (MATH 1026 or MATH 2015, CHEM 1036, BIOL 1105). (1H,3L,2C)

4444 (CSES 4444): MANAGED ECOSYSTEMS, ECOSYSTEM SERVICES, AND SUSTAINABILITY
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior or Senior Standing required. Pre: CSES 3114 or CSES 3134. (3H,3C)

4734 (CHEM 4734) (CSES 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: CSES 3114, CSES 3124, CHEM 2514 or CHEM 2535, CHEM 3114, (MATH 2015 or MATH 1026). (3H,3C)

4764 (CSES 4764): BIOREMEDIATION
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and wastewaters, as well as remediation of industrial waste streams. Pre: BIOL 2604. (3H,3C)

4774 (CSES 4774): RECLAMATION OF DRASTICALLY DISTURBED LANDS
Remediation, rehabilitation, revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and materials analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage. Pre: CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134 or CSES 3304 or GE OG 3304 or GEOS 3304. (3H,3C)

4854 (CSES 4854): WETLAND SOILS AND MITIGATION
Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetland functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetlands soils are mandatory. Pre: (CSES 3114, CSES 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CS ES 3134 or ENSC 3134. (2H,3L,3C)

4864: CAPTSTONE: ENV SCIENCE
Discussion based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan. The work plan will demonstrate the student’s understanding of contaminant fate and mobility in different environmental media and will be defended orally. Review and explore available careers in environmental science through seminars and working groups within environmental professionals discussing the role and responsibilities of environmental scientists in industry, consulting, regulatory agencies, and non-profits. ENSC majors only. Senior Standing. Pre: (CSES 3634

or ENSC 3634), (ENSC 4414), (CHEM 4734 or CSES 4734 or ENSC 4734), (C SES 4854 or ENSC 4854). (3L,1C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

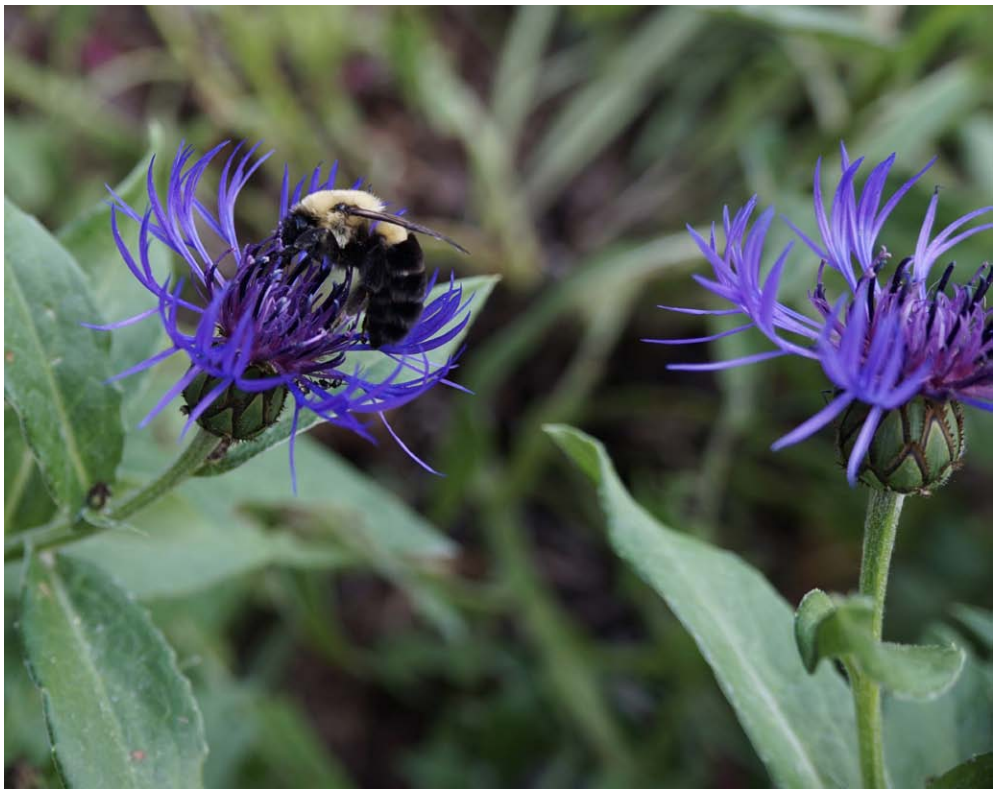
4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Entomology

Head: T. J. Kring
Professors: J.C. Bergh, T. J. Kring, T. P. Kuhar, D. M. Miller, D. G. Pfeiffer, S. M. Salom, and I. V. Sharakhov
Associate Professors: S. A. Entrekin, P. Marek, and S. L. Paulson
Assistant Professors:J. A. Auguste, M. J. Couvillon, G. Eastwood, A. D. Gross, R. Schurch, M. V. Sharakhov, and S. V. Taylor
Apiculturist: J. M. Wilson

Web: **www.ento.vt.edu**



Overview

Entomology is both a basic and an applied science which deals with the study of insects and their effects upon the health, economy, and welfare of humankind.

The department offers graduate programs leading to the MSLFS (thesis or non-thesis) and PhD (see Graduate Catalog). The departmental teaching, research, and extension programs are closely coordinated with those of other departments.

Insects are important as agricultural, health, and aesthetic pests and as beneficial organisms which serve as pollinators, biological control agents for pest populations, and as components of natural ecosystems. While entomologists have only scratched the surface in the study of insects and related arthropods, their research has yielded great benefits to humankind. Examples include reductions in human diseases transmitted by insects and the leadership shown by entomologists in the development of integrated pest management principles and procedures.

Undergraduate Course Descriptions (ENT)

1084: CAREERS IN ENTOMOLOGY
A comprehensive introduction of post-baccalaureate professional opportunities requiring knowledge of entomology including agricultural, medical and public health; forest and natural ecosystems; education and outreach; engineering and material science; biodiversity and evolution of arthropods. (1H,1C)

2004: INSECTS AND HUMAN SOCIETY
Past, present, and future role of insects in human society. Insect biology, diversity, and identification of common insects and other arthropods. Effects of insects on disease transmission, global food security, and human health. Management of pests of plants, animals, insects as food, and its effects on environmental pollution. Critique popular science communication and its effect on public policy. Human perceptions of insect conflicts, benefits of insects, and arthropod conservation across the world. (3H,3C)

2254: BEES AND BEEKEEPING

An introduction to honey bee biology, the social organization of the honey bee colony and to modern apiculture, including the use of bees for pollination. Topics on beekeeping include equipment, how to get started, and colony management practices. II (2H,2C)

2264: BEES AND BEEKEEPING LABORATORY
A laboratory course which examines the principles and practices of modern apiculture as they relate to honey bee biology. An emphasis is placed on students gaining practical field experience in modern management techniques. II Co: 2254. (3L,1C)

2804: BEES: BIOLOGY, DIVERSITY, AND SUSTAINABILITY
Foundational introduction to bees. Behavior, communication, and social organization of honey bees; diversity and use of alternative (non honey bee) pollinators; scientific inquiry in ecosystem services management; and current global challenges to and sustainable solutions for pollination in the modern-day agricultural landscape. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3014 (BIOL 3014): INSECT BIOLOGY
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional. Pre: (BIOL 1005, BIOL 1006) or (BIOL 1105, BIOL 1106) or (BIOL 1205H, BIOL 1206H). (2H,2C)

3024 (BIOL 3024): INSECT BIOLOGY LABORATORY
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required. I Pre: (BIOL 1005, BIOL 1006) or (BIOL 1105, BIOL 1106) or (BIOL 1205H, BIOL 1206H). Co: 3014. (1H,3L,2C)

3254 (BIOL 3254): MEDICAL AND VETERINARY ENTOMOLOGY
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed. Pre: (BIOL 1005, BIOL 1006) or (BIOL 1105, BIOL 1106) or (BIOL 1205H, BIOL 1206H). (3H,3C)

3264 (BIOL 3264): MEDICAL AND VETERINARY ENTOMOLOGY LABORATORY
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group. Pre: (BIOL 1105, BIOL 1106) or (BIOL 1005, BIOL 1006) or (BIOL 1205H, BIOL 1206H). Co: 3254. (3L,1C)

4254: INSECT PEST MANAGEMENT
Principles of insect pest management with application to the major insect pests found in Virginia. Pest management involves the utilization of all effective control practices in a program which is ecologically and economically efficient. This course is intended for all students with an interest in efficient agricultural production and in reducing losses to our most diverse competitor. One year of General Biology required. (2H,3L,3C)

4264 (PPWS 4264): PESTICIDE USAGE
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides. Pre: CHEM 2515 or CHEM 2536. (2H,3L,3C)

4354 (BIOL 4354): AQUATIC ENTOMOLOGY
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organism in aquatic ecology, pollution monitoring, and natural resource management. Pre: (BIOL 1005, BIOL 1006), (BIOL 1015, BIOL 1016) or (BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116). (3H,3L,4C)

4484 (BIOL 4484) (FIW 4484): FRESHWATER BIOMONITORING
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results. Pre: (BIOL 2804), (BIOL 4004 or BIOL 4354 or ENT 4354 or FIW 4424 or FIW 4614). (3H,3L,4C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Engineering Science and Mechanics

Department Head: Jennifer Wayne
N. Waldo Harrison Professor: Pamela Vandevord
Harry C. Wyatt Professor: S. M. Duma
Clifton C. Garvin Professor: R. C. Batra
Adhesive and Sealant Science Professor: D. A. Dillard
Tucker Professor: R. L. Mahajan (Lewis A. Chair in Engineering)
L. Preston Wade Professor: R. Davalos
Samuel Herrick Professor: H.C. Gabler
Professors: R.C. Batra, R. Davalos, D.A. Dillard, T. Dingus, S.M. Duma, H.C. Gabler, R. Gourdie, J.J. Lesko, R. Mahajan, S.H. McKnight, S.A. Ragab, T. Rikakis, J. Robertson, M.A. Stremler, and P. VandeVord
Associate Professors: R. De Vita, Z. Doerzaph, S. LaConte, Y.W. Lee, S. Poelzing, R. Queen, J. J. Socha, A.E. Staples, S. Thangjitham, C.D. Untaroiu, M. Van Dyke, and V.M. Wang
Assistant Professors: G. Cao, J. Chappell, J. Domann, A. Kemper, A. Morozov, J. Munson, S. Rowson, S. Verbridge, and E. Vlaisavlievich
Collegiate Assistant Professors: C. Arena and S. Arena, and J.K. Lord
Instructors: B. Aidi, C. Burgoyne, T.S. Chang, S. Davison, C. Galitz, J. Gragg, N. Johnson, H. Pendar, and S. Tahmasian
Professors Emeritus: N.E. Dowling, D. Frederick, J.W. Grant, R.A. Heller, S.L. Hendricks, R.M. Jones, L.G. Kraige, L. Meirovitch, D. Post, K.L. Reifsnider, D.J. Schneck, D.P. Telionis, and H.W. Tieleman
Affiliate Faculty: T. Furukawa, S. Huxtable, S. Johnson, R. Kapania, T. Long, R. Muller, A. Nain, M. Nussbaum, A. Onufriev, R. Parker, M. Patil, G. Seidel, S. Taheri, P. Tarazaga, L. Winfrey, C. Woolsey, and R. Yoon
Academic and Career Advisor: A. Sandridge

Web: **www.beam.vt.edu**

Overview

Mechanics is a fundamental area of science and engineering. It is an exciting, expanding field of learning with its roots grounded in the laws of motion formulated by Newton and the principles governing the behavior of solids and fluids, branching out in modern times into interdisciplinary fields such as new engineering materials (adhesives, composites, polymers, light metals), biomechanics, transportation, wind engineering, and vehicular structures. Although the problems to which they are applied may change, the basic principles of mechanics remain current and relevant.

Engineering Science and Mechanics has a rich tradition for providing an interdisciplinary engineering education. We strive to prepare our graduates to succeed in advanced graduate or professional study, industry, and government. In these activities, our alumni will:

- Apply fundamentals of engineering mechanics and related areas of applied science to define, model, and solve a wide range of engineering problems.
- Apply fundamental mathematical and scientific principles, as well as computational and experimental techniques, to the demands of engineering and scientific practice.
- Function on and lead teams that engage in new areas of research and development in engineering, particularly those that cross the boundaries of traditional disciplines.
- Maintain high productivity and high ethical standards.
- Continually enhance their knowledge throughout their careers.
- Communicate effectively to a broad range of audiences.

These educational objectives are supported by a curriculum that provides its graduates with:

- An ability to identify, formulate, and solve complex engineering problems by applying fundamental principles of engineering, science, mechanics, and mathematics.
- An ability to apply knowledge of mechanics and engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to communicate effectively orally, graphically, and in writing with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate computational analysis and experimentation in mechanics of materials, fluid mechanics, and dynamics; analyze and interpret data; and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
- An ability to recognize the importance of safety in all phases of engineering design and practice.

A total of 12 credit hours of technical electives and 6 credit hours of senior design give the student freedom to develop individually tailored programs of concentrated study. The department has emphasis areas in Biomechanics, Engineering physics, Fluid mechanics, Motions, or Solid mechanics. Exposure to the design process exists throughout the curriculum, culminating in a senior level capstone design course. The department offers official university degree options in Biomechanics and Engineering Physics.

The Cooperative Education Program is available to qualified candidates at undergraduate and graduate levels.

Undergraduate courses in engineering science and mechanics are taught on a service basis for all engineering curricula. A minor in engineering science & mechanics is available. The department offers graduate programs leading to M.S. (thesis and non-thesis option), M.Eng., and Ph.D. The department also participates in the Accelerated Undergraduate/Graduate Degree Program. Students with an interest in this program should contact the department for additional information.

The Engineering Science and Mechanics program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **https://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (BMES)

2004: CONCUSSION: MEDICAL, SCIENTIFIC AND SOCIETAL PERSPECTIVES
Broad, multidisciplinary description of concussion as it relates to variety of fields including: medicine, psychology, biomedical research, technology, equipment design, ethics, and law. Concussion modeling, diagnosis and treatment. Testing and instrumentation. Research efforts, credibility and conflicts of interest. Ethical considerations in sports, medicine, and science. Legal implications. (2H,3L,3C)

2104: INTRODUCTION TO BIOMEDICAL ENGINEERING
Methods of mathematical modeling and engineering analyses related to human physiology. Emphasis placed on fundamental concepts such as biomaterials, biomechanics, tissue engineering, biomedical imagining and nanomedicine. Broad spectrum of current biomedical engineering research areas. Pre: ENGE 1216 or ENGE 1414. Co: MATH 2214. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

29844: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3024: BME CELL ENGINEERING LABORATORY AND DESIGN
Principles of cell engineering, experiment design, quantitative alyses. Laboratory notebook keeping, report writing and oral presentation in a team setting. Measurement of biological molecules such as DNA, RNA, and proteins. Assessment of animal cell viability, migration, mechanics and interactions with biomaterials. Identification of cell phenotypes. Pre: 2104, ESM 2204. (3H,1L,2C)

3034: BIOINSTRUMENTATION LABORATORY AND DESIGN FOR LIVING SYSTEMS
Principles of biomedical sensors and their usage for experimental design. Collection of biological signals using analog signal amplifiication and filters, biopotentials, digital acquisition, digital filtering and processing. Analysis of physiological signals on living systems with focus on neural, cadiovascular,

respiratory, and muscular systems using a group problem solving approach. Instrumental regulation and safety considerations. Pre: 2104. (1H,3L,2C)

3114: PROBLEM DEFINITION IN BIOMEDICAL ENGINEERING DESIGN
Define open-ended biomedical engineering design projects, identify relevant broad social, global, economic, cultural needs, and technical design constraints. Technical skills to address complex biomedical engineering design challenges. Identify and define subjects worthy of future biomedical engineering design projects. Pre: 2104. (3H,3C)

3124: INTRODUCTION TO BIOMECHANICS
Basic principles of biomechanics. Basic musculoskeletal anatomy. Application of classical mechanics to biological systems. Emphasis placed on mechanical behavior (stress and strain), structural behavior, motion, and injury tolerance of the human body. Biomechanics of medical devices and implants. Advances in safety equipment used in automotive, military, and sports applications. Pre: 2104, ESM 2204, ESM 2304. (3H,3C)

3134: INTRODUCTION TO BIOMEDICAL IMAGING
Introduction to major biomedical imaging modalities. Emphasis on X-rays, computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), ultrasound, and optical imaging. Essential physics and imaging equations of the imaging system. Sources of noise and primary artifacts. Patient safety and clinical application. Pre: 2104, (MATH 2204 or MATH 2204H), PHYS 2306. (3H,3C)

3144: BIOMEDICAL DEVICES
Design and uses of biomedical devices for diagnosis and therapy of human and animal diseases. Disease eiologies, progression, risk factors, and epidemiology. Tissue, organ, and systems dysfunction and failure and relevance to life stages (pediatric, adolescent, adult, aged). Useful characteristics of engineered materials for device fabrication, including biocompatibility. Gaps between medical needs and current medical devices. Pre: 2104. (3H,3C)

3154: BIOINSTRUMENTATION AND ANALYSIS
Concepts of bioinstrumentation, including: circuits, op amps, signals and noise, filters, sampling theory, origin of biopotentials, electrodes, biopotential amplifiers, the heart and the electrocardiogram (ECG), the brain and the electroencephalogram (EEG), muscle and electromyography (EMG), pulse oximetry, blood pressure, interpreting physiologic measurements, mechanical sensors used in biomechanics research, strain gages, wheatstone bridge, piezoelectric and piezoresistive sensors, accelerometers, load cells, wearable activity sensors, heart rate monitors, consumer grade medical sensors. Pre: 2104. (3H,3C)

3184: PROBLEM SOLVING IN BME
Computational and analytical approaches to analyzing biological systems and solving biomedical engineering problems. Problem formulation and exploration of problem-solving techniques to validate computational solutions. Self-directed inquiry and team-based approaches that use reverse engineering, user-in-mind design, and engineering software tools. Pre: 2104. (3H,3C)

4015-4016: BME SENIOR DESIGN AND PROJECT
4015: Apply biomedical engineering principles to the design of an approved project using the team approach. Define problem statements and constraints for biological conditions. Use mathematical modeling tools. Develop conceptual design skills through lectures and exercises involving the design process. Integrate ethical, global and social issues in engineering. 4016: Apply biomedical engineering principles to develop solutions for an approved design project using a team approach. Complete a project resulting in prototype medical device, circuit, or system. Refine design skills through lectures and exercises involving the design process. Integrate ethical, global, environmental and social issues in engineering. Pre: 3114 for 4015; 4015 for 4016. (2H,3L,3C)

4064 (BMVS 4064): INTRODUCTION TO MEDICAL PHYSIOLOGY
An introductory to the principles of medical physiology. Designed primarily for (but not limited to), undergraduate students minoring in biomedical engineering, and other related engineering and physical sciences majors with little or no formal background in biological sciences. Basic principles and concepts

of human physiology. Special emphasis on the interactions of human systems biology in their entirety rather than individual genes and pathways. Pre: Junior standing or permission of instructor. (3H,3C)

4134: GLOBAL, SOCIETAL, AND ETHICAL CONSIDERATIONS IN BIOMEDICAL ENGINEERING
Overview of contemporary technological advances to improving human health. Comparison of healthcare systems, problems, and existing solutions throughout the developed and developing world. Consideration of legal and ethical issues associated with developing and implementing new medical technologies. Recognition and definition of gaps between medical needs and current methods and therapies between developed and developing countries. Conceptually design a novel technology. (3H,3C)

4154: COMMERCIALIZATION OF BME RES
Commercialization process applied to translational research. Regulatory aspects of biomedical engineering products and technologies (e.g. devices, diagnostics, drugs, biologics). Intellectual property, technology transfer processes, clinical trial design, commercialization of university research, modeling of development costs (e.g. cash flow and revenue projections). Small business startup approaches. Pre: 2104, 3024. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (ESM)

2014: PROFESSIONAL DEVELOPMENT SEMINAR FOR ESM STUDENTS
Topics designed to foster the professional development of the ESM student. ESM program objectives and outcomes. Overview of solid mechanics, fluid mechanics, and dynamics. Synergistic applications in biotechnology, adhesion science, and other applied areas. (1H,1L,1C)

2074 (AOE 2074): COMPUTATIONAL METHODS
Solving engineering problems using numerical methods and software, truncation and round-off error, root finding, linear and polynomial regression, interpolation, splines, numerical integration, numerical differentiation, solution of linear simultaneous equations. A grade of C- or better required in the prerequisite. Pre: ENGE 1114 or ENGE 1216 or ENGE 1434 or ENGE 1414. (2H,1.5L,2C)

2104: STATICS
Vector mechanics of forces and moments, free-body diagrams, couples, resultants, equilibrium of particles and rigid bodies in two and three dimensions, forces in trusses, frames, and machines, centroids, centers of mass, distributed forces, internal shear forces and bending moments in beams, shear and moment diagrams, friction, belt friction, area of moments of inertia, parallel axis theorem. Course requirements may be satisfied by taking MATH prerequisite prior to or concurrent with course. Pre: MATH 1226 Co: MATH 2204 or MATH 2204H or MATH 2224 or MATH 2406H. (3H,3C)

2114: STATICS & STRUCTURES
Vector algebra of forces, movements, couples and resultants. Free-body diagrams. Equilibrium of particles and rigid bodies in two and three dimensions. Friction. Forces in trusses and frames. Centroids, centers of mass, area moments of inertia. Internal axial forces, shear forces, and bending moments in bars in beams. Shear and moment diagrams. Stress and strain in bars in beams. Co: MATH 2204 or MATH 2204H or MATH 2406H. (3H,3C)

2204: MECHANICS OF DEFORMABLE BODIES

Concepts of stress, strain, and deformation. Factor of safety. Stress-strain relationships and material properties. Stress concentrations. Area moments of inertia. Axially loaded members, torsionally loaded members, bending of beams. Shear and moment diagrams. Stresses due to combined loading. Thin-walled pressure vessels. Transformation of stress including Mohr's circle. Beam deflections and buckling stability. Pre: (2104 or 2114), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

2214: STATICS AND MECHANICS OF MATERIALS
Forces, moment, resultants, and equilibrium. Stress, strain, and stress-strain relations. Centroids and distributed loads. Analysis of axially loaded bars and beams. Principal stresses and Mohr's circle, combined loading. Pressure vessels and buckling of columns. Partially duplicates 2104 and 2204. Must be CHE major. Co: MATH 2224. (3H,3C)

2304: DYNAMICS
Vector treatment of the kinematics and kinetics of particles and rigid bodies, Newton's laws, work and energy, impulse and momentum, impact, mass moments of inertia, rotating axes. Pre: 2104 or 2114, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). Co: MATH 2214. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Variable credit course.

3024: INTRODUCTION TO FLUID MECHANICS
Fluid properties and hydrostatics. Derivation and application of the continuity, momentum, and energy equation (Bernoulli's equation) for ideal and real fluid flow (laminar or turbulent). Dimensional analysis and similitude. Introduction to boundary layers, lift and drag. Pre: 2304, (MATH 2224 or MATH 2204 or MATH 2204H). (2H,2L,3C)

3034: FLUID MECHANICS LABORATORY
Introduction to experimental fluid mechanics. Dimensional analysis. Experiments on fluid properties, flow measurements, and flow visualization, including manometry, determining hydrostatic forces on submerged surfaces, applications of the impulse-momentum principle, velocity measurements, measuring drag forces, quantifying flow in channels. Modern data acquisition techniques. Pre: 2304, ECE 3054. Co: 3234. (3L,1C)

3054 (MSE 3054): MECHANICAL BEHAVIOR OF MATERIALS
Mechanical properties and behavior of solid materials subjected to static, cyclic, and sustained loads resulting from stress states, environments, and stress histories typical of service conditions; multiaxial failure criteria; behavior of cracked bodies; fatigue of materials; creep of materials; microstructure-property relationships; design methodologies. Pre: 2204, (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684). (3H,3C)

3064 (MSE 3064): MECHANICAL BEHAVIOR OF MATERIALS LABORATORY
Laboratory experiments on behavior and mechanical properties of solid materials. Tension, compression, bending, hardness, nano-indentation, and impact tests; behavior of cracked bodies; fatigue and crack growth tests; creep deformation; microstructure-property relationships; laboratory equipment, instrumentation, and computers. Pre: 2204. Co: 3054. (3L,1C)

3114: PROBLEM DEFINITION AND SCOPING IN ENGINEERING DESIGN
Define open-ended engineering design projects, identify relevant broad social, global, economic, cultural and technical needs and constraints, determine ways in which technical skills contribute to addressing complex engineering design challenges. Identify a capstone project for ESM 4015-4016. Pre-requisite:

Junior standing in ESM. Pre: 2014. (2L,1C)

3124: DYNAMICS II- ANALYTICAL AND 3-D MOTION
Review of Newton's Laws, introduction to Lagrange's equations, rotating coordinate systems, particle dynamics, systems of particles, rigid-body dynamics, small amplitude oscillations, holonomic and nonholonomic constraints, phase space and energy methods. Pre: 2304, MATH 2214, (MATH 2224 or MATH 2204 or MATH 2204H). (3H,3C)

3134: DYNAMICS III - VIBRATION AND CONTROL
Single-degree-of-freedom vibration, n-degree-of-freedom systems, continuous systems, nonlinear systems, system stability, introduction to the feedback control of dynamic systems. Pre: 3124, MATH 4564. (3H,3C)

3154: SOLID MECHANICS
Introduction to tensors, mathematical description of deformations and internal forces in solids, equations of equilibrium, principle of virtual work, linear elastic material behavior, solution for linear elastic problems including axially and spherically symmetric solutions, stress function solutions to plane stress and strain problems, solutions to 3-D problems, energy methods. Pre: 2204, (MATH 2214 or MATH 2214H). Co: MATH 4574. (3H,3C)

3234: FLUID MECHANICS I-CONTROL VOLUME ANALYSIS
Fluid statics. Control volume approach to flow analysis: conservation laws, pipe flows, compressible flow, open channel flow. Pre: 2304, PHYS 2306. (3H,3C)

3334: FLUID MECHANICS II-DIFFERENTIAL ANALYSIS
Introduction to continuum mechanics for fluid systems. Fluid kinematics. Differential approach to flow analysis: conservation equations, exact solutions, potential flows, viscous flows. Pre: 3234 or ME 3404. Co: MATH 4574. (3H,3C)

3444: MECHANICS LABORATORY
Concepts in instrumentation, data acquisition, and signal analysis. Measurements of mechanics quantities and phenomena associated with solid, fluid, and dynamical systems. Open-ended problem definition and approach formulation. Application and synthesis of engineering mechanics fundamentals to the modeling and solution of open-ended problems. Group-working skills and effective written and oral communication. Pre: 3234, 3034, 3054, 3064, 3124, ECE 3054. Co: 3134, 3334, 3154. (1H,3L,2C)

3704: BASIC PRINCIPLES OF STRUCTURES
Static equilibrium of forces and moments, concurrent and nonconcurrent force systems, center of gravity, concentrated and distributed loads. Solution of trusses. Stress and strain, elastic behavior of materials, cables and arches, shear, bending, and deformation in beams, indeterminate structures. Not available to students in engineering. (3H,3C)

4014: APPLIED FLUID MECHANICS
Analysis of flow over practical configurations, panel methods, Reynolds-averaged Navier-Stokes equations, turbulent boundary layers, flow separation and three-dimensional effects. Unsteady flows, fluid-structure interactions. Pre: 2074, 3016. (3H,3C)

4015-4016: CREATIVE DESIGN AND PROJECT I
Design of engineering systems and projects encompassing the principles and practices of engineering science and of the several engineering fields. Investigation and report on a supervised design project. Senior standing required. Instructor consent. Pre: 3114 for 4015; 4015 for 4016. 4015: (2H,3L,3C) 4016: (1H,6L,3C)

4024: ADVANCED MECHANICAL BEHAVIOR OF MATERIALS
Mechanical behavior of materials, emphasizing solid mechanics aspects and methods for predicting strength and life of engineering components. Plasticity, failure criteria, fracture mechanics, crack growth, strain-based fatigue, and creep. Microstructure-property relationships, and laboratory demonstrations. Pre: 3054 or MSE 3054. (3H,3C)

4044: MECHANICS OF COMPOSITE MATERIALS
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design. Pre: 2204. (3H,3C)

4084 (AOE 4084): ENGINEERING DESIGN OPTIMIZATION
Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines. Pre: (MATH 2224 or MATH 2204 or MATH 2204H). (3H,3C)

4105-4106: ENGINEERING ANALYSIS OF PHYSIOLOGIC SYSTEMS
Engineering analysis of human physiology. Physiologic systems are treated as engineering systems with emphasis input-output considerations, system interrelationships and engineering analogs. 4105 - Mass and electrolyte transfer, nerves, muscles, renal system. 4106 - cardiovascular mechanics, respiratory system, digestive systems, senses. Pre: 2304, MATH 2214. (3H,3C)

4114: NONLINEAR DYNAMICS AND CHAOS
Motion of systems governed by differential equations: stability, geometry, phase planes, bifurcations, Poincare' sections, point attractors, limit cycles, chaos and strange attractors, Lyapunov exponents. Forced, nonlinear oscillations: jump phenomena, harmonic resonances, Hopf bifurcations, averaging and multiple-scales analysis. Systems governed by discrete maps: return maps, cobweb plots, period-multiplying bifurcations, intermittency, delay coordinates, fractal dimensions. Pre: (2304 or PHYS 2504), (MATH 2214 or MATH 2214H). (3H,3C)

4154: NONDESTRUCTIVE EVALUATION OF MATERIALS
Concepts and methods of nondestructive evaluation of materials. Discussion of techniques and mathematical bases for methods involving mechanical, optical, thermal, and electromagnetic phenomena; design for inspectability; technique selection criteria; information processing and handling; materials response measurement and modeling; signal analysis. Pre: 3054, (PHYS 2206 or PHYS 2306). (3H,3C)

4194 (ME 4194): SUSTAINABLE ENERGY SOLUTIONS FOR A GLOBAL SOCIETY
Addresses energy metrics, global and US energy supply and demand, transitional energy sources (natural gas, petroleum, coal, nuclear), sustainable/renewable source (solar, geothermal, hydro, tidal, wind, biofuels), and methods for increasing efficiencies (energy storage, batteries, green building, conservation). Options for transportation, electricity, lighting and heating needs of industry, agriculture, community, and citizens. Production, transmission, storage, and disposal issues considered in the context of global political, economic, and environmental impacts. Senior Standing in major may be substituted for pre-requisite ENGL 3764. Pre: (CHEM 1035 or CHEM 1055), PHYS 2306, ENGL 3764. (3H,3C)

4204: MUSCULOSKELETAL BIOMECHANICS
Skeletal anatomy and mechanics. Muscle anatomy and mechanics. Theory and application of electromyography. Motion and force measuring equipment and techniques. Inverse dynamics modeling of the human body. Current topics in musculoskeletal biomechanics research. Pre: CS 1044 or CS 1064 or CS 1114 or AOE 2074 or ESM 2074 or ESM 2304. (3H,3C)

4224: BIODYNAMICS AND CONTROL
Study of human movement dynamics and neuromuscular control of multi-degree-of-freedom systems. Computational simulation of forward-dynamics and state-space linear control of human movement to investigate functional performance and neuromuscular pathology. Pre: 2304. (3H,3C)

4234: MECHANICS OF BIOLOGICAL MATERIALS AND STRUCTURES
Anatomy and physiology of connective tissue. Techniques for determining the mechanical response of biological soft and hard tissues. Includes static, viscoelastic, creep, fatigue, and fracture. Simplified models of biological structures. Creation of geometric models from medical imaging and computational modeling. Specific topics may include bone, cartilage, ligaments, tendon, teeth, and skin. Pre: 3054, (2074 or ME 2004). (3H,3C)

4245,4246: MECHANICS OF ANIMAL LOCOMOTION
4245: Mechanical and biological principles of terrestrial animal locomotion, including walking, running, jumping, climbing, burrowing, and crawling. Terrestrial locomotion- based bio-inspired design. 4246: Mechanical and biological principles of animal locomotion in fluids, including active and gliding flight, swimming, jetting, and running on water. Engineering design inspired by fluid based biological locomotion. Pre: 3054 for 4245; 3015 for 4246. (3H,3C)

4304: HEMODYNAMICS
Study of the human cardiovascular system and blood flow. Anatomy and physiology of the human heart, vascular system, and its organization. Blood physiology and rheology. Non-Newtonian blood flow models. Steady and pulsatile blood flow in rigid and elastic arteries. Pressure waves in elastic arteries. Three-dimensional blood flow in the aortic arch and flow around heart valves. Pre: 3334 or ME 3404. (3H,3C)

4404: FUNDAMENTALS OF PROFESSIONAL ENGINEERING
A refresher of basic principles and problem solving techniques involving twelve subject areas most common to all engineering curricula. The topics include those tested by the National Council of Engineering Examiners on the EIT (Engineer in Training) examination, the first requirement, in all fifty states, toward P.E. (Professional Engineer) licensing. Duplicates material of other engineering courses and impracticable for non-engineers, hence not usable for credit toward any degree. Pre: Junior and senior standing in Engineering or in Building Construction or Graduate students in Engineering. Pass/Fail only. (2H,2C)

4444 (AOE 4054): STABILITY OF STRUCTURES
Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion. Pre: AOE 3024 or CEE 3404. (3H,3C)

4614: PROBABILITY-BASED MODELING, ANALYSIS, AND ASSESSMENT
Uncertainty analysis of engineering data, parameters estimation, probability concepts, random variables, functions of random variables, probability-based performance functions and failure modes, risk and reliability functions, probability of failure and safety index, random sequences and stochastic processes, correlation functions and spectral densities, return period and extreme values, failure rates, performance monitoring and service life prediction. Pre: 2204. (3H,3C)

4734 (AOE 4024): AN INTRODUCTION TO THE FINITE ELEMENT METHOD
The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied. Pre: (CS 3414 or MATH 3414 or AOE 2074) or ESM 2074, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

4904: PROJECT AND REPORT
Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH

Honors Variable credit course.

Family Educational Rights and Privacy Act of 1974 (FERPA)

Family Educational Rights and Privacy Act of 1974

Annual Notification of FERPA Rights

To comply with the provisions of the Family Educational Rights and Privacy Act of 1974 (as amended), Virginia Polytechnic Institute and State University will not release education records or personally identifiable information contained therein, other than directory information, without the student's written consent.

Directory information at Virginia Polytechnic Institute and State University includes:

- Student's Name
- Local and Permanent Address(es)
- Telephone Number(s)
- VT Email Address
- Major Field of Study (Including Second Majors, Minors, etc.)
- Whether a Student is Currently Enrolled
- Enrollment Status (Full-time, Half-time, etc.)
- Class (Freshman, Sophomore, etc.)
- Academic Level (Associate, Undergraduate, Graduate, Professional)
- Anticipated Date of Graduation
- Certification of Application for Degree
- Dates of Enrollment
- Degree(s) Earned (Including Date, Honors and Level of Distinction)
- Participation in Officially Recognized Activities and Sports
- Weight and Height of Members of Athletic Teams
- Electronic Theses and Dissertations (ETD)

Directory information will be withheld upon the written request of the student. Such prohibition against release generally does not extend to record requests from other school officials at this institution who have an educational need to know, state and federal education authorities, courts or accrediting organizations. Questions concerning this policy may be referred to the Office of the University Registrar.

FERPA Disclosure

Due to the laws covering confidentiality, it is a violation of the regulations for anyone to release non-directory information (grades, course enrollment, class schedule, standing) about any student to anyone without permission from the student. The Family Educational Rights and Privacy Act (FERPA) requires the student to authorize the university prior to release of any academic record information to a third party. Completion of the online form (Hokie SPA) allows the student to approve disclosure of his/her academic record information to parent(s) and/or guardian(s) via an assigned "Pass Code". University officials must request the pass code prior to the release of any requested information. The disclosure will remain valid until the student removes the authorization.

Tax Dependent? The Commonwealth of Virginia requires Virginia's colleges and universities to release academic record information to parents of tax dependent students. This requirement is allowable within the guidelines of FERPA. If the student is a tax dependent of his/her parent or guardian, please denote that information by checking "YES" in the question column, "Are you a Tax Dependent?" on the online FERPA disclosure form (Hokie SPA). Students are informed of any release of information prior to disclosure.

Notification of Rights Under FERPA

The Family Educational Rights and Privacy Act (FERPA) affords students certain rights with respect to their education records. These rights include the following:

1. The right to inspect and review the student's education records within 45 days of the day the University receives a request for access. Students must submit to the Office of the University Registrar written requests that identify the record(s) they wish to inspect. The university official will make arrangements for access and notify the student of the time and place where the records may be inspected. If the records are not maintained by the University official to whom the request was submitted, that official shall advise the student of the correct official to whom the request should be addressed.
2. The right to request the amendment of the student's education records that the student believes are inaccurate or misleading. They should write the University official responsible for the record, clearly identify the part of the record they want changed, and specify what is inaccurate or misleading. If the University decides not to amend the record as requested by the student, the University will notify the student of the decision and advise the student of his or her right to a hearing regarding the request for amendment. Additional information regarding the hearing procedures will be provided to the student when notified of the right to a hearing.
3. The right to consent to disclosures of personally identifiable information contained in the student's education records, except to the extent that FERPA authorizes disclosure without consent. One exception which permits disclosure without consent is disclosure to school officials with legitimate educational interests or concerns of health and safety. A school official is a person employed by the University in an administrative, supervisor, academic or research, or support staff position (such as health staff); a person or company with whom the university has contracted (such as an attorney, auditor, or collection agent); a person serving on the Board of Visitors; or a student serving on an official committee, such as a disciplinary or grievance committee, or assisting another school official in performing his or her tasks. A school official has a legitimate educational interest if the official needs to review an education record in order to fulfill his or her professional responsibility.
4. The right to file a complaint with the U.S. Department of Education concerning alleged failures by Virginia Tech to comply with the requirements of FERPA. The name and address of the office that administers FERPA is:

Family Policy Compliance Office
U.S. Department of Education
400 Maryland Avenue, SW
Washington, DC 20202-5920
http://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html

Students may also file a complaint with the University Registrar:

Rick Sparks
250 Student Services Building
Blacksburg, Virginia 24061-0134
(540) 231-7951

The Family Educational Rights and Privacy Act indicates that students and former students should be granted the opportunity to change their names on education records upon the production of evidence showing that the name has changed. The following procedure applies to requests for changes to the name appearing on a student's education record:

- Complete Request for Change in Name form in the Office of the University Registrar
- Provide a photocopy of a Social Security card that reflects the new name and a valid drivers license or other form of photo identification
- Provide a photocopy of a birth certificate, marriage certificate or license, divorce decree, court order, or naturalization papers including certificate number, petition number, and registration number

Please note that all documentation used in support of this request should reflect the name for which you are requesting the change.

The Privacy Act of 1974 (U.S. Public Law 93-579, Sect. 7) requires that the university notify students that disclosure of a Social Security number is voluntary unless employed by the university or receiving federal financial aid. Pursuant to the 2003 State Code of the Commonwealth of Virginia, no student identification card may display the social security number as an identifier. Effective with students entering Fall 2003 and beyond, a generated identification number will be utilized as the default unique identifier. This generated number will be nine digits in length and will begin with the number, "9", nine. The generated student identification is defined as personally identifiable information by federal legislation, FERPA (Family Educational Rights and Privacy Act) (U.S. Public Law 93-579, Sect. 7), and is prohibited from disclosure except to education officials with legitimate educational interest.

For students who entered Virginia Tech prior to Fall 2003, the social security number was the default student identification number. Effective with the entering class of Fall 2003, a nine digit generated identifier is assigned to each student. Use this identifier when the student identification number is requested by a university official. Important note: disclosure of the social security number may be required by different university offices if required by the Code of the Commonwealth of Virginia or Federal statute.

Required Demographic Information

Virginia Tech policy requires annually the collection of specific demographic data for each student: local mailing address, emergency contact entry or emergency contact confirmation, VT Alerts Opt In or Opt Out action, and review of the Virginia Tech Student Conduct Policy. Students will be prohibited from registration until the information is provided.

Missing Person Contact

Student(s) may denote a specific third party as emergency contact as primary in cases of missing person(s). Visit Hokie SPA, choose the Hokie Plus menu, add 'new emergency contact'. In the pull down selection for relationships, choose "Missing Persons Contact". In case of such an emergency, the University will first contact the missing person designee before any alternate emergency contact(s).

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Finance, Insurance, and Business Law

Head: Vijay Singal
Suntrust Professor of Finance: G.E. Morgan
J. Gray Ferguson Professor of Finance: V. Singal
Alumni Distinguished Professor and R. B. Pamplin Professor of Finance: A.J. Keown
R. B. Pamplin Professor of Finance: G.B. Kadlec
R.V. and A.F. Oliver Professor of Investment Management: R. Kumar
R.E. Sorensen Professor: J. Hiller
Wells Fargo Professor in Financial Risk Management: S. Mansi
Professors: R. Lytton
Emeritus Professors: D. Shome and G.R. Thompson
Associate Professors: R.S. Billingsley, J.C. Easterwood, R. Edelen, and J. Xu
Assistant Professors: A. MacKinlay, B. Paye, and P. Ye
Professor of Practice: M. Kender
Associate Professor of Practice: D. Klock and C. Spicer
Assistant Professor of Practice: J. Malone
Instructors: D. Andre, C. Damico, B. Hart, K. Hogan, E. Johnsen, M. Jones, J. Lineberry, B. Murray, W. Newton, J. Powell, A. Price, T. Reilly, J. Showalter, and E. Wikle

Web: **www.finance.pamplin.vt.edu**
E-mail: **fin@vt.edu**

Overview

Finance is a specialty that works with the development, allocation and use of monetary resources within established legal and ethical frameworks, while understanding and mitigating the associated risks. Money is a critical component of the economic system and its flow is the sustaining force of the U.S. and global economy. Therefore, in working with how governments, corporations, intermediaries, and households utilize their financial assets finance professionals are an integral part of how the economy perpetuates the standard of living that we enjoy.

Traditionally there are three separate but related fields within finance: 1) corporate financial management or "business finance" which focuses on the internal decisions of companies to raise funds and invest in corporate assets; 2) investment management which focuses on the purchase and sale of stocks and bonds or their derivatives by individuals and institutions; and 3) financial services management, which focuses on the management and regulation of institutions and the role that financial institutions play in the economy.

The undergraduate program in Finance meets the requirements of students who desire specialized careers in financial management. Students gain expertise in both accounting and finance, essential for success as a financial professional. The case-oriented focus of coursework requires students to apply their knowledge and strengthen their oral and written communication skills. The department offers Options in Certified Financial Planning, Corporate Financial Management, Financial Accounting, FinTech and Big Data Analytics, Investment Management and Chartered Financial Analyst (CFA), Real Estate Finance, and Risk Management and Banking.

The curriculum offers courses in finance, insurance, and business law, but a major only in finance.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Students select different combinations of elective courses to fulfill the requirements of one or more of the seven options offered. The seven options are:

- Certified Financial Planning
- Corporate Financial Management
- Financial Accounting
- FinTech and Big Data Analytics
- Investment Management and Chartered Financial Analyst (CFA)
- Real Estate Finance
- Risk Management and Banking

Undergraduate Course Descriptions (FIN)

2114: INVESTMENTS AND FINANCIAL LITERACY
Examines budgeting; taxes; long- and short-term borrowing; credit card debt; student loan debt; ethical issues in both lending and investments; insurance; the investment process; the financial markets; investing in common stock, bonds, and mutual funds; major financial decisions, and retirement planning. Coverage of time value of money and risk and return will provide fundamental tools for valuation and financial decision-making. (3H,3C)

2164: SURVEY OF FINANCE AND CAREER PLANNING
Career opportunities and job search strategies in the finance field with reference to the finance courses that best help the student identify a career in his/her selected field. Pass/Fail only. Pass/Fail only. (1H,1C)

2954: BUSINESS STUDY ABROAD
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. Pre: Instructor's consent and the completion of 30 SH with a minimum GPA of 3.0 or departmental consent. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3044 (REAL 3044): FINANCING REAL ESTATE PROJECTS
Methods and tools for analyzing commercial real estate from the perspective of a developer. Land valuation, equity and debt financing, measuring project returns, public private partnerships, and real estate capital markets. Pre: REAL 2004 or UAP 2004, REAL 2034, FIN 3104 or FIN 3134. (3H,3C)

3054: LEGAL AND ETHICAL ENVIRONMENT OF BUSINESS
Key concepts of law, ethics, and regulation applicable to business operations and management; includes international aspects. Legal and ethical decision-making, critical applications, and relationship of business to society. Legal systems, torts, contracts, property, administrative law topics, agency, ethical frameworks. Pre: Junior Standing. (3H,3C)

3074: LEGAL, ETHICAL, AND FINANCING ISSUES FOR ENTREPRENEURS
Introduction of key legal, ethical, and financing topics for new ventures. Ethical decision making in entrepreneurial situations. Choosing among legal entities for financing and ownership goals. Company

governance. Creating and protecting intellectual property. Identifying and choosing financing options for new ventures. Employment issues for entrepreneurial firms. Basics of contracts. Enterprise risk management and compliance. Exit strategies. Partially duplicates FIN 3054 (Legal and Ethical Environment of Business). Students may not receive credit for both courses. Junior Standing. (3H,3C)

3104: INTRODUCTION TO FINANCE
Overview of financial decision-making process focusing on the creation of wealth. Topics covered include the time value of money, how stocks and bonds are valued, financial decision-making within a firm, an overview of financial markets, and investment banking. The course is designed for finance and non-finance majors. Pre: ACIS 2115, (BIT 2405 or STAT 3005 or STAT 3604 or STAT 4604 or STAT 4705 or STAT 4714 or STAT 3615 or STAT 3616), (ECON 2005 or ECON 2025H). (3H,3C)

3124: FINANCIAL PLANNING FOR PROFESSIONALS
Analysis of financial needs, from the context of the individual, household or small business owner, related to financial situation (cash management and use of debt), income taxes, risk management, retirement planning, investment planning, estate planning, and other special needs. Utilizes mathematical and computing skills. FIN students may be excused from the AAEC 2104 prerequisite with instructor permission. FIN 3134 may be taken prior to or concurrent with course. Co: 3134. (3H,3C)

3134: FINANCIAL ANALYTICS
This course provides an understanding of the theory and practice of making financial decisions for corporations. Key concepts and computational skills in finance. Time value of money, risk and return, security valuation and interest rate determination. Pre: (ECON 2005 or ECON 2025H), ACIS 2115, (BIT 2405 or STAT 3005 or STAT 3604 or STAT 4604 or STAT 4705 or STAT 4714 or STAT 3615 or STAT 3616). Co: ACIS 2504. (3H,3C)

3144: INVESTMENTS: DEBT, EQUITY AND DERIVATIVES
Risk, return and portfolio theory, knowledge of financial securities and markets. Introduction to mutual funds, financial securities and markets, portfolio analysis, market efficiency and performance evaluation, bond valuation, term structure of interest rates, interest rate risk, security analysis and stock valuation, options, Black-Scholes option pricing model, and futures. Must have a grade of C or better in prerequisite of FIN 3134, and Junior standing required. Pre: 3134. (3H,3C)

3154: CORPORATE FINANCE
Types of financial management decisions that firms make, the environment in which decisions are made, the available choices and decision criteria, and valuation consequences of these choices. Determination of a firm’s optimal debt- equity ratio, estimation of cost of capital, evaluation of capital investments, divided policy, and sources of financing. Must have a grade of C or better in prerequisite of FIN 3134, and Junior standing required. Pre: 3134. (3H,3C)

3174: FINANCE CAREER STRATEGIES
Analysis and research of career opportunities in financial industry. Study of future trends in careers in financial industry. Development of short and long-term career goals. Building and developing a professional network. Identify types of finance interviews. Ethical negotiation of job offers. (1H,1C)

3204: RISK AND INSURANCE
Surveys the concept of risk as it applies to the nuclear family and as a socio-economic force in society. Risk management techniques utilizing social and proprietary insurance to neutralize the effect of risks inherent in daily life: termination or suspension of earnings, liability exposures, and potential losses of real and personal property values. Junior standing required. (3H,3C)

3254: CREDIT RISK ANALYSIS
Analysis of the risks inherent in credit/lending decisions. Pricing of loans, appropriate documentation, and monitoring of the creditworthiness of businesses and individuals. Emphasis on making credit decisions and structuring of credit agreements. Pre: 3134. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4004: WILLS, TRUSTS, AND ESTATES
Examines the control of assets through the creation and use of trusts, and the control of property through estate planning. The course emphasizes financial planning through estate management both personally and as a part of a business plan. Pre: 3055 or 3054 or 3074. (3H,3C)

4014: CYBERLAW AND POLICY
Cyber law, ethics, and policy in a changing world. National and international methods of regulation and protection of fundamental rights. Legal, ethical, and policy issues for Internet governance, speech, privacy, cybersecurity, surveillance, electronic commerce, intellectual property, and "cyberwar." Examination of current issues and texts in light of fundamental ethical and legal principles and global discourse. Pre: Junior standing. (3H,3C)

4104: RETIREMENT PLANNING
Overview of planning needs, products, and strategies used by financial professionals to help businesses, small business owners, and individuals choose and implement an effective retirement plan. Must have prerequisite or permission of instructor. Pre: 3124 or AAEC 3104. (3H,3C)

4114 (AAEC 4114): FINANCIAL PLANNING TECHNOLOGY & MODELING
Use of professional software applications that support financial planning analyses, plan preparation, wealth management, and client relationships. Principles of personal investment portfolio research, construction, and performance applied to comprehensive financial planning and wealth management. Pre: (AAEC 3104 or FIN 3124), FIN 3144. (3H,3C)

4124: CLIENT RELATIONSHIP MANAGEMENT
Investigation of socio-psychological factors and communication/interviewing strategies that foster trust-based relationships essential to the success of financial advisors and other financial service professionals. Graduate students are expected to have completed AAEC 3104 or FIN 3124 or an equivalent course or may enroll with permission of the instructor. Pre: AAEC 2104 or AAEC 3104 or FIN 3124. (3H,3C)

4134: FINANCIAL PLANNING APPLICATIONS
Integration of financial planning content in the resolution of client situations in the context of ethical and compliant workplace practices. Utilizes a case analysis approach applying financial planning processes and procedures. Graduate students are expected to have similar background from equivalent courses or professional experience or may enroll by permission of the instructor. ACIS 4344 or FIN 4004 taken simultaneously with the course can be substituted for the prerequisites. Co: AAEC 4104 or FIN 4104. Pre: (AAEC 3104 or FIN 3124), FIN 3144, FIN 3204. Co: 4104. (3H,3C)

4144: INTERNATIONAL FINANCIAL MANAGEMENT
Explores the environmental challenges facing the financial manager of a multinational corporation and the tools and techniques developed to meet such challenges. Pre: 3104. (3H,3C)

4154: REAL ESTATE FINANCE
This course introduces the fundamentals of both real estate financing and investment. Conventional mortgages as well as more creative financing methods will be analyzed. The secondary market for mortgages and relevant institutional factors also will be examined. Investment analysis of real estate will be viewed in a capital budgeting framework; appropriate tax law will be discussed as it affects real estate cash flows. Pre: 3134. (3H,3C)

4214: FINANCIAL MODELING IN EXCEL
Concepts of finance applied to the construction of models in Excel. Construct models of financial statement to evaluate financial strategies for a firm; design risk/return models for investment portfolio strategies using equity and/or debt securities; build models to optimize bond portfolios including interest rate sensitivities, duration and convexity; develop models to analyze and dynamically hedge option and futures portfolios; assemble binomial tree models on American options; build simulation models to evaluate different types of options. Pre: 3144. (3H,3C)

4224: FIXED INCOME SECURITIES: ANALYSIS AND MANAGEMENT

Analysis of fixed income securities, including corporate bonds, U.S. Treasury notes and bonds, municipal bonds, money market securities, and home mortgages. The analysis include interest rate risk, credit risk, bond valuation theory, and the valuation of embedded options in the bond contract. Theories of the term structure of interest rates are presented. Must have a grade of C or better in prerequisites of FIN 3144 and 3154. Pre: 3144, 3154. (3H,3C)

4225-4226: ANALYTICS FOR FIXED INCOME SECURITIES AND PORTFOLIO MANAGEMENT
4225: Management of fixed income securities in an experiential setting. Bond pricing and investment. Credit analysis and portfolio strategies in fixed income. Introduction to advanced analytical techniques in bond and portfolio analytics. Conduct research on individual companies, industries, and countries. Membership in BASIS (Bond And Securities Investing by Students). Must have a B- or better in prereq. Pass/Fail Only. Pass/Fail only. Pre: 3134 for 4225; 4224, 4225 for 4226. Co: 4224 for 4225. (3H,3C)

4234: VENTURE CAPITAL AND INVESTMENT BANKING
Explores the venture capital cycles of fund-raising, investing in portfolio firms, and exiting the investment. Focuses on the role of investment banking in the exiting of investments by taking the portfolio firms public through initial public offerings. Includes a conceptual component and an applied component in which the case method is used. Must have a grade of C or better in prerequisites of FIN 3144 and 3154. Pre: 3144, 3154. (3H,3C)

4244: ASSET VALUATION AND CORPORATE GOVERNANCE
The effect of corporate governance on asset-valuation. Case oriented course focusing on the valuation of non-financial assets such as projects, business units, private and public firms. Topics include method of comparables, discounted cash flow methods and the real options approach to valuation. Examines the external and internal governance mechanisms for preserving and enhancing the value of a firm. Must have a grade of C or better in prerequisites of FIN 3144 and 3154. Pre: 3144, 3154. (3H,3C)

4254: BANK MANAGEMENT AND FINANCIAL SERVICES
The functions of financial service providers and the risks inherent in the provision of banking and other financial services. Regulatory background and issues. Case oriented course. Must have a grade of C or better in prerequisites of FIN 3144 and 3154. Pre: 3144, 3154. (3H,3C)

4264: MANAGING RISK WITH DERIVATIVES
The types, payoff, and pricing of derivative securities and contracts and their application in managing financial risks faced by corporations. Topics include options, forwards, futures and swaps; managing foreign currency risk, interest rate risk, stock price risk, and commodity price risk; and risk management techniques. Must have a grade of C or better in prerequisites of FIN 3144 and 3154. Pre: 3144, 3154. (3H,3C)

4274: EQUITY SECURITIES: ANALYSIS AND MANAGEMENT
Advanced valuation and analysis of equity securities with case applications. Critical analysis of advanced equity asset pricing models. Analysis of advanced equity portfolio management techniques, equity portfolio performance measurement, and equity portfolio performance attribution analysis. Identification and analysis of market anomalies and recent developments in equity analysis. Must have grade of C or better in prerequisites of FIN 3144 and 3154. Pre: 3144, 3154. (3H,3C)

4275-4276: ANALYTICS FOR EQUITY SECURITIES AND PORTFOLIO MANAGEMENT
Selection and management of equity securities in an experimental setting. Analysis, selection, and investment in common stocks. Introduction to advanced analytical techniques in equity evaluation and portfolio analytics. Research individual companies, industries, economic sectors, and national and global macroeconomic trends. Use appropriate software to develop financial models. Present buy and sell recommendations for actual execution in the portfolio. Maintain a high level of fiduciary responsibility. Pass/Fail only. Membership in SEED (Student-Managed Endowment for Educational Development). Pass/Fail only. Pre: 3134 for 4275; 4274, 4275 for 4276. Co: 4274 for 4275. (3H,3C)

4284: FREE MARKETS, INDIVIDUAL FREEDOM, AND ECONOMIC WELFARE
Course exposes students to various viewpoints on the role free markets can and do play in promoting individual freedom. Allocation of scarce resources, and in enhancing welfare. Explores the strengths and

weaknesses of capitalism by critically evaluating the relationship between the economic efficiency achieved by capitalism and the attainment of welfare objectives. Other topics include current items such as globalization, price controls, income equality, outsourcing, corporate pricing power though monopoly/oligopoly, and government regulation of the economy. (3H,3C)

4294: COMMODITY INVT. PORTFOLIOS
Application of fundamental commodity analysis and valuation techniques utilized to create a commodity investment portfolio in an experiential setting. Analysis, selection, and advanced analytical techniques in domestic and international agricultural, energy and metal commodities applied to a simulated investment in a commodity portfolio. Maintain a high level of fiduciary responsibility through developing, maintaining, and interpreting portfolio performance on a daily basis. Pre: 3144. (3H,3C)

4314: FIELD PROJECTS IN FINANCE
Finance-related business projects with external clients, which will include gathering and analyzing data, understanding relevant financial issues in a business context, formulating recommendations, and presenting analyses and recommendations in oral and written form. Pre: 3144, 3154. (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Fish and Wildlife Conservation

Head: Joel W. Snodgrass
Professors: P. L. Angermeier, K. A. Alexander, C. A. Dolloff, J. D. Fraser, E. A. Frimpong, C. A. Haas, E. M. Hallerman, W. A. Hopkins, Y. Jiao, S. M. Karpanty, M. J. Kelly, D. J. Orth, and D. F. Stauffer
Associate Professors: L. J. Castello, J. M. Ford, J. W. Jones, and J. A. Parkhurst
Assistant Professors: M. Cherry, A. Dayer, L. Escobar, Francesco Ferretti, and Holly Kindsvater
Adjunct Professors: B. Czech, P. Grobler, M. Joos Vandewalle, D. Hawley, T. J. Newcomb, E. Smith, H. Schwarz, J. Walters, and Y. Palti
Career Advisors: *Fish Conservation Undergraduate* - E. M. Murphy (231-6959), *Wildlife Conservation Undergraduate* - C. A. Haas (231-9269)

Web: **www.fishwild.vt.edu**

Fish Conservation

The Fish Conservation program is for students interested in research and management of aquatic animals and ecosystems, including wild fish and shellfish, endangered species, and hatchery-raised fish. Most graduates work for state or federal fisheries agencies, environmental consulting firms, or public utilities. Because the more challenging and rewarding jobs require a master's degree, the program emphasizes preparation for graduate study.

Wildlife Conservation

The Wildlife Conservation program is for students interested in research and management of terrestrial animals and ecosystems, including game birds and mammals, non-game animals, and endangered species. Most graduates work for state or federal wildlife agencies, environmental consulting firms, or private land management companies. Because the more challenging and rewarding jobs require a master's degree, the program emphasizes preparation for graduate study.

Undergraduate Course Descriptions (FIW)

2114: PRINCIPLES OF FISH AND WILDLIFE CONSERVATION
Basic principles, key people, agencies and laws guiding the science-based conservation and management of fish and terrestrial animals. Conservation and management of organisms, habitats, and human users examined in terms of biological, physical, ecological, ethical and sociological theories and practices. Local to global illustration from both recreational and commercial resources. (3H,3C)

2234: FISH, FISHING, AND CONSERVATION
Sensory perception, behavior, and consciousness in fish. Principles, as related to fish and why they matter, fish conservation ethics, food security, recreational fishing, and responsible fishing practices. Ethical reasoning applied to the contemporary issues of conservation and use of fish, such as subsistence fishing, fish farming, marine protected areas, highly migratory fishes, sharks tourism, and ornamental fishes. (3H,3C)

2244: NATURAL HISTORY OF THE GREAT SMOKY MOUNTAINS
Introduction to the natural environments of the Great Smoky Mountains National Park through an intensive, 7-day, on-site residential experience. Emphasis on improving identification skills and enhancing knowledge of the local geology and biodiversity endemic to the Great Smoky Mountains, including the plants, animals, and invasive species common to its terrestrial and aquatic communities. Examination of environmental problems and policies unique to the Great Smoky Mountains, as influenced by local history and culture. Pre: 3 credits in general education from within the Reasoning in the Natural Sciences areas. (2H,3L,3C)

2314: WILDLIFE BIOLOGY
Summary of biological characteristics of wild birds and mammals, especially relating to management by humans. Physiological, functional, structural, and behavioral adaptations of individuals to their environments and foods. Pre: (BIOL 1105 or BIOL 1205H), (BIOL 1106 or BIOL 1206H). (3H,3C)

2324: WILDLIFE FIELD BIOLOGY
Systematics, identification, and natural history of common native vertebrates and plants. Exposure to habitats/ecosystems of western Virginia. Observation, collection, and reporting of field data. Self-scheduled field and media lab activities required. (1H,6L,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3414: DISEASE ECOLOGY AND ECOSYSTEM HEALTH
Principles of disease ecology with practical application of concepts using both human and wildlife disease examples. Importance of emerging infectious disease in conservation planning, public health and wildlife management. Pre: BIOL 1105, BIOL 1106. (3H,3C)

3514: FISHERIES TECHNIQUES

Application of field and laboratory methods in fisheries management and research. Experience with fisheries equipment and techniques. Pre: 2114. (1H,6L,3C)

3954: STUDY ABROAD
Variable credit course.

3964: INTERNSHIP THROUGH DIRECTED FIELD STUDY
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4114: BIODIVERSITY CONSERVATION
Advanced concepts and practices related to the conservation and enhancement of biological diversity. Understanding and analysis of causes of biological scarcity. Designing actions to mitigate biodiversity loss. Integration of legal, economic, social, and biological principles to develop solutions to conservation of organisms, populations and ecosystems. Cannot be taken for credit by Wildlife Conservation (WLC) majors. Pre: 2114. (3H,3C)

4214: WILDLIFE FIELD TECHNIQUES
Field research methods for wild vertebrates in terrestrial environments. Application of research methodology including animal capture and marking, determination of sex, age, and condition, radio telemetry and map/compass/GPS orienteering, non-invasive methods of capture, habitat selection, and supervised group research projects. Pre: 4414, STAT 3615. (2H,3L,3C)

4314: CONSERVATION OF BIOLOGICAL DIVERSITY
Principles and practices of conserving biological diversity. Causes, consequences and rates of extinction. Application of philosophical, biological, sociological and legal principles to the conservation of genes, plant and animal species and ecosystems. Pre: 4414, 4434. (3H,3L,4C)

4324 (FREC 4324): GENETICS OF NATURAL AND MANGAGED POPULATIONS
Introductory genetics with an emphasis on evolutionary processes relevant to natural and managed populations of both plant and animal species. Traditional and modern genetics, including quantitative and population genetics, molecular evolution, genomics, and biotechnology. Pre: BIOL 1105, BIOL 1106, (STAT 3005 or STAT 3615 or FOR 3214 or FREC 3214). (3H,3C)

4334: MAMMALOGY
Biology of mammals, including evolution, systematics, anatomy, physiology, ecology, and conservation challenges. Laboratory focus on identification, morphology, and zoogeography. Pre: BIOL 2704 or BIOL 2704H. (3H,3L,4C)

4344: HERPETOLOGY
Biology of amphibians and reptiles, including evolution, systematics, anatomy, physiology, ecology, and conservation challenges. Laboratory focus on identification, morphology, and zoogeography. Pre: BIOL 2704. (3H,3L,4C)

4414: POPULATION DYNAMICS AND ESTIMATION
Population growth, structure, and regulation of fish and wildlife populations including harvested populations, non-harvested populations, and small or declining populations. Methods of estimating demographic parameters such as population size, survival, and recruitment. Population viability analysis and genetic considerations in population dynamics. Pre: 2324. (3H,3C)

4424: ICHTHYOLOGY
Morphology and physiology, systematics, zoogeography, and identification of fishes. (2H,6L,4C)

4434: WILDLIFE HABITAT ECOLOGY AND MANAGEMENT
Relationship of wildlife species to their habitats. Factors influencing distribution and abundance of wildlife populations. Vegetation succession and structure, habitat classification, modeling wildlife habitat relationships and management of habitats in forests, agricultural lands, rangelands, riparian/wetland and

urban areas. Pre: 2114. (3H,3C)

4454: HUMAN-WILDLIFE CONFLICTS
Current and emerging human-wildlife interactions that lead to conflict; application of knowledge of animal behavior and life history, population dynamics, human dimensions, and ecosystem functions to analyze conflicts and formulate effective resolution; legal statutes and regulatory constraints on resolution; reliance on case studies of existing conflict situations to gain applied experience in diagnosing and solving human-wildlife conflicts using Vertebrate Integrated Pest Management protocols. Pre: Senior Standing. (3H,3C)

4464: HUMAN DIMENSIONS OF FISHERIES AND WILDLIFE
Values, attitudes, and opinions of people toward fish and wildlife. Social, economic, legal, and political aspects of fisheries and wildlife management. Roles of professionals and the public in fish and wildlife policy processes. Contemporary fish and wildlife policy issues. Senior standing required. Pre: 2114. (3H,3C)

4474: WILDLIFE HABITAT EVALUATION
Application of methods for habitat evaluation through a group project to develop a habitat management plan. Students apply methods used to quantify habitat quality and assess impacts of various management actions. Emphasis is on Habitat Suitability Index models and the Habitat Evaluation Procedures approach of the US Fish and Wildlife Service. Pre: STAT 3005. Co: 4434. (3L,1C)

4484 (BIOL 4484) (ENT 4484): FRESHWATER BIOMONITORING
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results. Pre: (BIOL 2804), (BIOL 4354 or BIOL 4004 or ENT 4354 or FIW 4424 or FIW 4614). (3H,3L,4C)

4534: ECOLOGY AND MANAGEMENT OF WETLAND SYSTEMS
Introduction to the variety of wetland systems found in North America, though emphasis will focus on eastern and mid-Atlantic wetland systems. Origin and processes of formation of wetlands, functions and values of wetlands, wetland delineation, wetland classification, regulatory processes affecting wetlands. Objectives of and management techniques used to protect and/or manipulate wetland systems for wildlife and other human needs. Enrollment restricted to junior, seniors and graduate students. Pre: BIOL 3204. (2H,3L,3C)

4614: FISH ECOLOGY
Interactions of fish with the physical and biological environment. Adaptations of organisms, populations, and communities. Impacts of human activities on major aquatic ecosystems and important fishes. Ecological principles for management of important sport, commercial, and prey fishes. Pre: BIOL 1006. (3H,3C)

4624: MARINE ECOLOGY
Marine organism, biological, ecological, chemical and physical processes of marine ecosystems in open sea, coastal and benthic environments, research methods and models in marine ecosystem simulation; fisheries in a dynamic ecosystem: human interference and conservation. Pre: BIOL 2804 or GEOS 3034. (3H,3C)

4714: FISHERIES MANAGEMENT
History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management and setting management objectives. Synthesis of fish population dynamics and manipulation, habitat improvement, and human management to achieve objectives. Case studies of major fisheries. Pre: 3514. (3H,3L,4C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Modern and Classical Languages and Literatures

Chair and : R.J. Watson

Alumni Distinguished Professor: J. Bixler
Professors: J. Folkart, D. Stoudt, J. Watson, V. Venkatesh
Associate Professors: C. Andrango-Walker, E. Austin, E. Bauer, A. Becker, M.C. Caña-Jiménez, M. Coburn, A. Dickow, R. Efird, A. Gudmestad (Associate Chair), M. Guèye, S. Hofer, S. Johnson, N. Milman-Miller, C. Noirot, R. Shryock, S. Sierra, N. Sinno, F. Teulon
Assistant Professors: J. Jaque, B. Klausmeyer, Y. Minkova, G. Montero, R. Phillips, P. Ridge, N. Sokhey, and T. Zhao
Instructors: A. Azzam, R. Chang, A. Dalton, E. Hallerman, M. Hatzios, Y. Kumazawa, J. M. Layne, T. McKagen, T. Mercer, S. Mishra, X. Moore, R. Nassereddine, K. Rutsala, M. Sguerri, C. Steer, M.C. Teo, and Y. Younos
Advanced Instructors: A. Hesp, N. López
Professors of Practice: A. Sobrado

Web: **https://liberalarts.vt.edu/.../department-of-modern-and-classical-languages-and-literatures.html**

Overview

The study of languages and literatures opens doors to international understanding and the appreciation of ancient and contemporary cultures and civilizations. The department gives interested students of the university the following opportunities:

- To major or minor in a language;
- To prepare for careers in international organizations, the Foreign Service, government, business or industry, teaching;
- To participate in a study abroad program;
- To obtain humanities and social sciences credits on an elective basis;
- To fulfill undergraduate language requirements;
- To become a more aware and informed citizen of the world.

Majors and minors are offered in Classical Studies, French, German, Russian, and Spanish. Additional minors are offered in Arabic, Chinese Studies, Classical Languages, French for Business, Italian, Japanese Studies, and Latin. The department also offers instruction in modern Greek, Hebrew, Korean, and Portuguese.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

A minimum grade of C (2.0) must be earned by majors and minors in all courses required for the major or minor.

Arabic

Arabic Minor

To obtain a minor in Arabic, a student must complete 18 hours in Arabic at the 2000 level and above, including 2774, 3105, and 3106.

Chinese

Chinese Studies Minor

To obtain a minor in Chinese Studies, a student must complete 18 hours of approved courses, including at least 12 hourse of Chinese.

Classical Studies

Classical Studies Major

To complete the interdisciplinary major in Classical Studies, a student must complete 36 hours: 18 in Classical Studies (History, Art & Art History, Mythology, Literature, Culture, Religion, etc.) and 18 hours in Classical Languages (Ancient Greek and/or Latin). Variable-content courses may be repeated for credit.

Classical Studies Minor

To obtain an interdisciplinary minor in Classical Studies, a student must complete 18 hours in Classical Studies, with at least 6 hours at the 3000-level or above. Variable-content courses may be repeated for credit.

Classical Languages Minor

To obtain a minor in Classical Languages, a student must complete 18 hours in Classical Languages (Ancient Greek and/or Latin), with at least 6 hours at the 3000-level or above. Variable-content courses may be repeated for credit.

French

French Major

To complete a major in French, a student must complete 33 hours at the 3000-level and above, including:

- 3105, 3106, *3126, **3304, 3314, and 4154;
- three of the following: 3164, 3205, 3206, 3305, 3306, 3424, 3444, 3454
- two of the following: ***4164, 4314, 4324.

*Students who demonstrate satisfactory oral proficiency by examination may be exempted from French 3126, in which case the three credits earned by examination can count toward the 33 credits required for the major. Students not placing into or out of 3126 are strongly advised to take 3125, which is an elective designed to enable students to achieve the level of oral proficiency required for entry into 3126.

** Although 3304 is a prerequisite for 3305, 3306, 3314, 3424, 3434, 3444, and 3454, it may be waived in some instances. Contact the French program director for details.

***French 4314 and 4324 are variable content courses that may be repeated for credit.

Except with consent in special cases, 2964: Field Study, 2984: Special Study, 4964: Field Study, 4974: Independent Study, 4984: Special Study, and 4994: Undergraduate Research may not be used to complete the major.

Students placed at a higher level may substitute any 3xxx or 4xxx course beyond the major requirements for FR 3105 or FR 3106.

French Minor

To obtain a minor in French, a student must complete 18 hours in French at the 2000-level and above, 12 of which must be taken at the advanced level, including 3105 and 3106. Students must take at least one French culture course (any 34xx course, or 3314). In some instances, French 3164 may count toward the minor.

Students placed at a higher level may substitute any course beyond the minor requirements for FR 2105 or FR 2106.

French for Business Concentration

To obtain the French for Business concentration, a student must complete 18 hours at the 1000-2000 level, including the following courses: 1105, 1106, 2105, 2164, 2714, and a CLE Area 7 course or any Study Abroad credit course.

French for Business Minor

The French for Business minor requires 18 hours of French at the 2000-level and above. The minor must include the following courses: 3105, 3106; two of the following: 2164, 3164, 4164; and two of the following: 2714, 3205, 3206, 3304, 3314, 3424, 3434, 3444, 3454, 4154.

German

German Major

To complete a major in German, a student must complete 30 hours at the 3000-level and above, including the following required courses: 3105, 3106, *3126, 3204, 3305, 3306, 4154, and six additional hours of 4000-level coursework. Major elective credit for courses taught in English may be awarded for up to two courses with the approval of the adviser.

*Students may be exempted from German 3126 through demonstration of satisfactory oral proficiency by examination, in which case three additional hours of advanced elective course work in German will be necessary to complete the required 30 hours. Students not placing into or out of 3126 are strongly advised to take 3125, which is designed to enable students to achieve the level of oral proficiency required for entry into 3126; for most students, the hours represented by 3125 will be in addition to the minimum of 30 required for the major.

The 30 hours must be in German courses exclusive of 3125, 3195, 3196, 3414, and 4964

German Minor

To obtain a minor in German, a student must complete 18 hours in German at the 2000-level and above, 12 of which must be taken at the 3000 or 4000 level, including the required courses 3105 and 3106. Up to one of the following advanced level courses taught in English may count towards the German minor with the approval of the adviser: 3414, 3474, 4334.

Italian

Italian Minor

To obtain a minor in Italian, a student must complete 18 hours of course work in Italian at the 2000 level and above, 12 of which must be taken at the advanced level and must include 3105, 3106, 3305, and 3306.

Japanese

Japanese Studies Minor

To obtain a minor in Chinese Studies, a student must complete 18 hours of approved courses, including at least 12 hourse of Chinese.

Latin

Latin Minor

To obtain a minor in Latin, a student must complete 18 hours of course work in Latin, including 6 hours at the 3000 level or above. Variable-content courses may be repeated for credit.

Russian

Russian Major

To obtain a major in Russian, students must take 33 hours, including the following: 2105, 2106, 2734, 3105, 3106, 3124, 3304, 3314, 4204*, and 4304*.

*Variable-content courses may be repeated for credit. At least one of these courses will need to be taken twice in order to meet the requirement that at least 24 of the required 33 hours be taught in Russian.

Russian Minor

To obtain a minor in Russian, a student must complete 18 hours in Russian at the 2000-level and above, 12 of which must be taken at the advanced level, including 3105 and 3106.

Spanish

Spanish Major

To complete a major in Spanish, a student must complete 33 hours at the 3000-level and above, including:

- 3105, 3106, *3126, 3304;
- five of the following: at least two from the group 3404, 3414, 3444, 3464, 3474, 3484; and at least one from the group 3494, 3514, 3524, 3534, 3544, 3554.
- two 4xxx-level courses.

* Spanish students may earn credit by exam for Spanish 3126 through demonstrating satisfactory oral proficiency by examination. Students not placing into or out of 3126 are strongly advised to take 3125, which is designed to enable students to achieve the level of oral proficiency required for entry into 3126. For most students, the hours represented by 3125 will be in addition to the minimum of 33 required for the major.

Except with consent in special cases, the 33 hours must be in Spanish courses exclusive of: 2964, 2984, 4964, 4974, 4984, and 4994.

Students must earn 33 SPAN credits regardless of initial course placement. If you have AP or IB Spanish credit, see your Spanish Advisor.

Spanish Minor

To obtain a minor in Spanish, a student must complete 18 hours at the 2000-level and above, 12 of which must be taken at the advanced level, including 3105, 3106, 3304, and one of the following: 3404, 3414, 3444, 3464, 3474, 3484, 3494, 3514, 3524, 3534, 3544, 3554.

Students must earn 18 SPAN credits regardless of initial course placement. If you have AP or IB Spanish credit, see your Spanish Advisor.

Restrictions for all majors and minors

1000-level courses do not count for Majors or Minors in French, German, Russian or Spanish.

1000-level courses do count toward Majors and Minors in Classical Studies, Latin, and Classical Languages.

Questions about courses numbered 4964, 4974, 4984, and 4994 should be addressed to the director of the specific language program or the department chair.

No more than six hours of 4964 (Field Study) may be taken.

Courses designated 3195-3196 do not satisfy the foreign language requirement for the University or the College of Liberal Arts and Human Sciences.

Courses designated as 3954 (Study Abroad) may carry major credit only if the student is eligible to pursue courses above the second-year level; otherwise credits will be assigned at the first and second-year level as appropriate in each individual case.

Independent Study

The minimum grade point averages required for independent study in the Department of Modern & Classical Languages & Literature are a 3.3 in 3000- and 4000-level courses in the language of the independent study, a 2.5 overall average, and a 3.0 in all course work completed after the freshman year. Students wishing to enroll in courses designated 4974 (Independent Study) must receive permission from the instructor and the department chair during the term prior to enrollment. No more than eight hours of independent study and/or undergraduate research combined may be counted toward a degree.

Study Abroad

The department encourages students to work and/or study abroad. Information relating to work and/or study abroad programs is available from the department office (331 Major Williams) and from the Global Education Office.

The department offers summer study abroad programs in France, Germany, Italy, Japan, Mexico, Oman, Senegal, Russia, Spain (Madrid and the Camino de Santiago), and semester- or year-long exchange programs in Caen (France), Oviedo (Spain), and Quito (Ecuador).

Information related to work and/or study abroad programs not sponsored by the department is available from the Global Education office.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways) (see "**Academics**") and toward the Foreign Languages degree.

Satisfactory progress requirements toward the B.A. in Classical Studies, B.A. in French, B.A. in German, B.A. in Russian, and B.A. in Spanish can be found on their major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Repeating Work Completed

Students who have studied a foreign language may not repeat work completed at another institution without advance permission of the instructor. For example, those who have studied four years of a language in high school cannot study that language at the elementary level for credit. Native speakers may not take language courses below the 3000 level in their native language.

Undergraduate Course Descriptions (FL)

1984: SPECIAL STUDY
Variable credit course.

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (ARBC)

1105-1106: ELEMENTARY ARABIC
Fundamentals of Arabic with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. ARBC 1105 is for students with no prior knowledge of the language. (3H,3C)

1114: ACCELERATED ELEMENTARY ARABIC
Proficiency-oriented approach to Elementary Arabic, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops speaking, listening comprehension, reading comprehension, writing, and cultural competency at the novice-high level. Duplicates 1105 and 1106. Not recommended for Native Speakers. (6H,6C)

2105-2106: INTERMEDIATE ARABIC
2105: First course in the intermediate-level sequence in Arabic. Review of grammar with increasing emphasis on reading, writing, cultural competency, and oral communication. Pre: 1106 for 2105; 2105 for 2106. (3H,3C)

2774: ARAB CULTURE AND CIVILIZATION
Overview of Arab culture and civilization, with an emphasis on the modern Middle East. Familiarizes students with the geography, history, politics and sociology of the Arab world and identifies the cultural forces that shape current events in the region. Explores the impact of colonialism, war, religion, gender relations, and media technologies in the Arab world. Taught in English. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

2984: SPECIAL STUDY
Variable credit course.

3105-3106: ADVANCED ARABIC
3105: First course in the advanced-level sequence in Arabic. Practice in communication skills in Arabic both orally and in writing, including review of grammar, directed composition, and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Second course in the advanced-level sequence in Arabic. Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers. Pre: 2106 for 3105; 3105 for 3106. (3H,3C)

3124: ARABIC FOR ORAL PROFICIENCY
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. Provides students with the skills necessary to modify the pronunciation and grammar rules of Modern Standard Arabic in order to speak and comprehend conversational Arabic at the intermediate level. Emphasis on speaking, listening comprehension, daily-life experiences, body-language, and cultural knowledge. Not recommended for native speakers. Pre: 2105. (3H,3C)

3304: MODERN ARABIC LITERATURE IN TRANSLATION
Familiarizes students with the cultural, intellectual, and historical contexts of major Arabic literary texts. Provides students with skills necessary to analyze the rhetorical devices and literary techniques of the texts under study. Texts from major literary genres include poems, short stories and realist and experimental novels. Explores topics including postcolonialism, resistance, war, romance, tradition, religion, feminism, and pop culture. Taught in English. (3H,3C)

3474: TOPICS IN ARAB CINEMA
Examination of the cultural, intellectual, and historical contexts of Arab cinematic works. Exploration of the ways in which Arab cinema reflects the dynamics of political, economic, and social change in modern Arab societies, as well as how the Arab world is represented in Western films. Variable topics such as war and conflict, terrorism, postcolonialism and movements for national independence, feminism, gender and sexuality, and globalization. Taught in English. Variable content. May be repeated 2 times with different content for a maximum of 6 credits. (3H,3C)

3514: MEDIA ARABIC
Reading and listening comprehension, analysis, writing, translation, and cultural conventions pertaining to Arabic print and broadcast media. Pre: 2105. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4154: ADVANCED COMPOSITION AND STYLISTICS
Intensive work in written Arabic. Devoted to enhance the grammar, stylistics, writing, and cultural competency of Arabic students at the advanced level. Emphasis on analyzing and writing personal, academic, and professional texts, with attentiveness to the cultural conventions common to each genre. Pre: 3105. (3H,3C)

4334: RESEARCH IN ARAB CULTURE
Interpretation of sources about Arab culture. Examination of the historical, intellectual, and cultural contexts of major cultural productions. Integration of authentic Arabic language texts into research. Analysis of the impact of gender, race, and class on cultural productions in the Arab world. Taught in English. Pre: 2105, 2774. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (CHN)

1105-1106: ELEMENTARY CHINESE
Fundamentals of the Chinese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Chinese. (3H,3C)

2105-2106: INTERMEDIATE CHINESE
Emphasizes comprehension of written and spoken Mandarin Chinese, communication in Chinese; study of some literature and culture of the Chinese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent. X-grade allowed. Pre: 1106. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105-3106: ADVANCED CHINESE
3105: Practice in communication skills in Chinese both orally and in writing, including review of grammar, directed composition, and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers. Pre: 2106 for 3105; 3105 for 3106. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (CLA)

1134 (RLCL 1134): THE ANCIENT MEDITERRANEAN WORLD
Ancient cultures of the Mediterranean world with a focus on their embodiments in the arts, literature, history, philosophy, and religion. Emphasis on Greek, Hellenistic and Roman cultures, their interrelationships with each other and their historical, cultural, material and intellectual encounters with contemporary Mediterranean cultures as their influence on later and modern cultures. (3H,3C)

2224 (HIST 2224): ANCIENT GREEK AND ROMAN WOMEN
Examines the history of ancient Greek and Roman women from ninth century BCE to the fall of the Roman Empire. Analyzes contributions of women to each civilization. Studies construction of and contemporary debates about women's ascribed social, political, and cultural roles. (3H,3C)

2234 (HIST 2234): CLASSICS IN THE MODERN WORLD
Examines the influences, traditions, and receptions of the ancient Greeks and Romans in the modern world, especially in the United States. Explores the re-interpretation of the ancient Greek and Roman world across mediums, and by leaders and governments in diverse societies. Discusses contexts and ideologies of re-makings of the ancient Greek and Roman world. (3H,3C)

2434: FAIRYTALE, FOLKLORE, AND MAGIC: POPULAR LITERATURE IN ANCIENT GREECE & ROME
Survey of ancient Greek and Roman popular literature. Introduces students to a wide array of texts, ranging from the ancient novel, popular compilations (e.g. books of marvels, fables, and jokes), ritual texts, funerary inscriptions, and folklore/fairytales. Examination of how scholars define popular literature as a category and introduction of contemporary approaches to it. Exploration of the connection of ancient Greek and Roman tales to international ones from different cultures and perspectives. Special attention to the depiction of private rituals in Greek and Latin literature. In English. (3H,3C)

2444 (ENGL 2444) (RLCL 2444): ANCIENT GREEK AND ROMAN MYTHOLOGY
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English. (3H,3C)

2454 (ENGL 2454): ANCIENT GREEK AND LATIN LITERATURE IN ENGLISH TRANSLATION
A variable content course devoted to the study of major works of Ancient Greek and Latin literature in English translation. May be repeated for credit with different content. In English. No knowledge of Ancient Greek or Latin required. Not for credit toward a Latin Minor. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (FR)

1105-1106: ELEMENTARY FRENCH
Fundamentals of the French language with emphasis on grammar, reading, composition, and conversation. 1105 for students with no prior knowledge of the language; 1106 for students who have completed 1105 or less than three years in high school. X-grade allowed. (3H,3C)

1114: ACCELERATED ELEMENTARY FRENCH
Proficiency-oriented approach to elementary French, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Taught in French. (3H,3C)

2105-2106: INTERMEDIATE FRENCH
Emphasizes comprehension of written and spoken French, communication in French, literature, and culture of French-speaking world. X-grade allowed. Pre: 1106 for 2105; 2105 for 2106. (3H,3C)

2164: INTERMEDIATE BUSINESS FRENCH
This course emphasizes all four language skills (reading, writing, speaking, and listening) by focusing on various facets of the world of business and technology. It also develops students' understanding of French institutions and business practices. Pre: 2105. (3H,3C)

2714: INTRODUCTION TO FRENCH CULTURE AND CIVILIZATION
French culture and civilization from prehistoric cave paintings to the present. Interdisciplinary approach to literature, film, art, achitecture, intellectual movements, and lifestyle in the context of French political history, society, and globalization, including elements of French culture that arrived through conquerors, migrants, and immigrants. Taught in English. (3H,3C)

2794H: INDEPENDENT STUDY
Variable credit course.

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105,3106: COMPOSITION, CONVERSATION AND GRAMMAR
Development of the ability to write and speak through the effective use of French syntax and morphology. Increased reading and listening skills through the study of authentic materials in the target language. Understanding the role of culture in communication. Conducted in French. Pre: 2106 or 2164. (3H,3C)

3125-3126: FRENCH FOR ORAL PROFICIENCY
For acquisition of measured levels of proficiency in speaking and understanding spoken French. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to "Intermediate-high" on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or "S -1+" on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to "Advanced" on the ACTFL-OPI or a "2" on the FSI scale. Admission by oral exam. Pass/Fail only. X-grade allowed. Pre: 3105, 3106. (3H,3C)

3164: ADVANCED BUSINESS FRENCH
In this skills-based course, students learn to use appropriate French technical vocabulary for different business contexts, do translation, write professional correspondence, and read articles related to the worlds of business, economics, and finance. Cross-cultural differences regarding the work place are also a focus of the course. Pre: 3105, 3106. (3H,3C)

3205,3206: FRENCH CULTURE AND CIVILIZATION
3205: Patterns of French life and culture in the context of social, intellectual, and institutional changes from the Middle Ages to the French Revolution. 3206: From the French Revolution to the present with an introduction to other francophone parts of the world. Pre: (3105, 3106). (3H,3C)

3304: INTRODUCTION TO FRENCH LITERATURE
Introduction to French literature through analysis and discussion of selected texts from different periods and genres. Methods, terminology, and practice of literary analysis. Intensive writing component. X-grade allowed. Pre: 3105. (3H,3C)

3305,3306: SURVEY OF FRENCH LITERATURE
Readings in French literature from the Middle Ages to the present to acquaint students with literary techniques and contexts. Pre: 3304, 3105, 3106. (3H,3C)

3314: INTRODUCTION TO FRANCOPHONE STUDIES
Introduction to the literatures and cultures of French-speaking regions outside of France including North Africa, the Caribbean, Sub-Saharan Africa, and Quebec. Examination of thematic and cultural aspects of literatures of those regions within their socio-historical contexts. Exploration of movements and notions as Negritude, postcolonialism, identity, race, and nation as they relate to the legacy of colonial France. Development of research skills such as finding appropriate sources and proper citation, and of intercultural sensitivity through analysis of works outside Western traditions. Taught in French. Pre: 3105, 3106, 3304. (3H,3C)

3424: FRENCH CULTURE FROM MIDDLE AGES TO RENAISSANCE
Overview of major events, currents, ideas, works, and figures in French culture from the Middle Aes to the end of the Renaissance. Emphasis on nation-building and cultural production. Critical reading and writing in French. Analysis of a variety of literary texts and cultural artifacts affects from a chronological and thematic perspective. Taught in French. Pre: 3304. (3H,3C)

3434: FRENCH CULTURE FROM BAROQUE TO REVOLUTION

Overview of major events, currents, ideas, works, and figures in French culture from the Baroque era to the French Revolution (1610-1799). Emphasis on nation-building and cultural production in a European and Global context. Critical reading and writing in French. Analysis of a variety of literary texts and cultural artifacts from a chronological and thematic perspective. Taught in French. Pre: 3304. (3H,3C)

3444: FRENCH CULTURE FROM ROMANTICISM TO BELLE ÉPOQUE
Overview of major events, movements, ideas, works, and figures in French culture from the Romantic period (1800) through the Belle Époque (1914). Emphasis on literary and cultural works in their social and historical contexts. Critical reading and analysis in French. Study of the impact of French history on French culture. Interpretation of intercultural experiences according to different world views. Taught in French. Pre: 3304. (3H,3C)

3454: FRENCH CULTURE FROM WORLD WARS TO GLOBAL PRESENT
Overview of major events, currents, ideas, works, and figures in French culture from World War I to the present, a period characterized by colonialism, world conflict, and globalization. Analysis of literary and cultural works in their social and historical contexts, toward an understanding of the French language as a global idiom involving diverse worldviews and cultures. Critical reading and writing in French. Taught in French. Pre: 3304. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4154: ADVANCED COMPOSITION AND STYLISTICS
Intensive work in written French. Development of the student's ability to write clear, correct, and articulate French in a variety of modes (e.g., epistolary style, the formal and informal essay). Writing intensive. Pre: 3106. (3H,3C)

4164: SPECIAL TOPICS IN BUSINESS FRENCH
A variable content course devoted to developing and perfecting highly advanced language skills through the study of special topics in the French and francophone business worlds. Emphasis on a mastery of specialized French for professional settings. May be repeated for credit with different content. Taught even years. Pre: 3106, 3164. (3H,3C)

4314: STUDIES IN FRENCH LITERATURE
In-depth study of a selected topic in French literature, such as an author, a group of authors, a literary movement or genre during a specific period of French literary history (i.e., Voltaire, the Pleiade, Romanticism, the nouveau roman). May be repeated for credit with different content. Pre: 3304, (3305 or 3306 or 3314). (3H,3C)

4324: SPECIAL TOPICS IN FRENCH LIFE, LITERATURE AND LANGUAGE
In-depth study of a selected topic in French culture or language as manifested in creative and historical literature, music, art, film, etc., such as phonetics, translation techniques, or the staging of dramatic works in French. May be repeated for credit with different content. Pre: 3105, 3106, 3304, 3314 or 3424 or 3434 or 3444 or 3454. (3H,3C)

4794: SENIOR TUTORIAL IN FRENCH STUDIES
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. May be taken twice for credit with different content. Must be pre-arranged three weeks before end of previous semester. One 4000 level French course, senior standing, French major, and consent of French Section required. (1H,1C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (GER)

1105-1106: ELEMENTARY GERMAN
Fundamentals of the German language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school. (3H,3C)

1114: ACCELERATED ELEMENTARY GERMAN
Proficiency-oriented approach to elementary German, designed for learners who wish to progress rapidly through the beginning stages of language learning. It develops the four language skills (speaking, listening, reading, writing) in a cultural context. Partially duplicates GER 1105 and 1106. (6H,6C)

2105-2106: INTERMEDIATE GERMAN
Review of grammar with increasing emphasis on reading, writing, and oral communication. Pre: 1106. (3H,3C)

2114: ACCELERATED INTERMEDIATE GERMAN
Proficiency-oriented approach to intermediate German, designed for learners who wish to progress rapidly through the intermediate stages of language learning. The course strengthens the four language skills (speaking, listening, reading and writing) in a cultural context. Accelerated version of GER 2105-2106. Pre: 1106. (6H,6C)

2724: INTRODUCTION TO GERMAN CULTURE AND CIVILIZATION
Examination of major German-language cultural movements, works, and figures from the earliest times to the present. Interdisciplinary exploration of German-language literature, film, art, architecture, music, and theatre in the context of the history of the German-speaking world. Analysis of Germanic culture, values and beliefs, and politics in their European and international context. Taught in English. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105-3106: GRAMMAR, COMPOSITION AND CONVERSATION
Progressive and comprehensive review of German syntax and morphology. Development of written and oral expression. Development of reading and listening skills and introduction to contemporary public debates through the study of original German materials. Understanding of the role of social, historical,

political, and cultural contexts and of fact- based reasoning in communication. Introduction to cultural research in German. Taught in German. GER 3105: review of basic and complex grammatical structures; GER 3106: review of advanced grammatical structures, writing intensive. Pre: 2106 or 2114 for 3105; 3105 for 3106. (3H,3C)

3125-3126: GERMAN ORAL PROFICIENCY
For acquisition of measured levels of proficiency in speaking and understanding spoken German. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to "Intermediate-high" on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or "S-1+" on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to "Advanced" on the (ACTFL-OPI) or a "2" on the FSI scale. Admission by oral exam. Taught alternate years. Pass/Fail only. (3H,3C)

3204: CULTURE OF THE GERMAN-SPEAKING COUNTRIES
Study of German, Austrian, and Swiss culture and civilization from the Middle Ages to the present, including literature, art, architecture, film, and music. Pre: 3104 or 3105 or 3106. (3H,3C)

3305,3306: SURVEY OF GERMAN LITERATURE
Overview of genres and themes in German literature. Familiarizes students with the socio-historical context necessary to discuss critically literary themes and analyze literary texts. 3305: examines major works from the High Middle Ages to the end of Classicism; 3306: examines major works from Romanticism to the present. Taught in German. Pre: (3105, 3106) or (3105, 3204) or (3105, 3306) or (3106, 3204) or (3106, 3306) for 3305; 3105 or 3106 for 3306. (3H,3C)

3414 (ENGL 3414): GERMAN LITERATURE IN ENGLISH
A variable content course devoted to the study of major German literary works in English translation. May be repeated with different content. May not be taken for credit toward a major or minor in a foreign language. No knowledge of German required. In English. One 2000- level English literature course required. (3H,3C)

3474: TOPICS IN GERMAN CINEMA
Critical issues in the history of German Cinema. Aesthetic characteristics of major periods, with an emphasis on cinematic trends and ways in which films reflect cultural developments in German-speaking countries. Taught in English. Variable content. May be taken twice for credit with different content. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4154: ADVANCED COMPOSITION AND STYLISTICS
Intensive advanced work in written German. Development of the student's ability to write clear, correct, and articulate German in a variety of modes. Style analysis. Writing intensive. Pre: 3106. (3H,3C)

4304: AGE OF GOETHE
Major writers of the age of Goethe: Goethe, and Schiller; the development of German Classicism. Pre: 3105, 3106, 3306. (3H,3C)

4314: STUDIES IN 19TH-CENTURY LITERATURE
Variable content course devoted to the study of 19th century drama, lyric, and prose. May be repeated for credit with different content. Pre: 3105, 3106, 3306. (3H,3C)

4324: STUDIES IN 20TH-CENTURY LITERATURE
A variable content course devoted to the study of major literary works of the 20th century. May be repeated for credit with different content. Pre: 3105, 3106, 3306. (3H,3C)

4334: SPECIAL TOPICS IN GERMAN LIFE, LITERATURE, AND LANGUAGE

Variable content course devoted to the study of various aspects of German culture, literature, and language. May be repeated for credit with different content. Pre: (3105, 3106), (3305 or 3306). (3H,3C)

4794: SENIOR TUTORIAL IN GERMAN STUDIES
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. Must be pre-arranged three weeks before end of previous semester. May be taken twice for credit with different content. PRE: one 4000-level German course, major with senior standing, and consent required. (1H,1C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (GR)

1105-1106: CLASSICAL AND NEW TESTAMENT GREEK
Introduction to classical/New Testament Greek, for development of reading ability. 1105: Short readings of graded difficulty. 1106: Introduction to the basics of the introduction of language, continued, with the introduction of select longer passages from ancient Greek authors. (3H,3C)

1205-1206: ELEMENTARY MODERN GREEK
Fundamentals of modern Greek with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. GR 1205 is for students with no prior knowledge of the language. (3H,3C)

2104 (RLCL 2104): GREEK NEW TESTAMENT
Review and refinement of the language is combined with readings from the New Testament in ancient Greek, with attention to historical context and analysis of the language May be repeated with different content for a maximum of 9 credits. Pre: 1106. (3H,3C)

2114: READINGS IN CLASSICAL GREEK LITERATURE
Study of several major writers of ancient Greek literature. Selections from epic poetry, tragedies, philosophical dialogues, history and oratory. May be repeated with different content for a maximum of 9 credits. Pre: 1106. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (HEB)

1105-1106 (JUD 1105-1106): ELEMENTARY MODERN HEBREW
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases. (3H,3C)

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Undergraduate Course Descriptions (ITAL)

1105-1106: ELEMENTARY ITALIAN
Fundamentals of the Italian language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school. (3H,3C)

1114: ACCELERATED ELEMENTARY ITALIAN
Proficiency-oriented approached to elementary Italian, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 1105 and 1106. (6H,6C)

1204: ITALIAN LANGUAGE AND CULTURES
Fundamentals of the Italian Language with emphasis on developing proficiency in practical language use and cultural competency. Offered off campus. Does not fulfill the University foreign language requirement.

Variable credit course. Variable credit course.

2105-2106: INTERMEDIATE ITALIAN
Emphasizes comprehension of written and spoken Italian, communication in Italian, literature, and culture of Italy. Pre: 1106. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105,3106: CULTURE COMPOSITION AND CONVERSATION
Practice in oral and written communication in Italian on a variety of topics in Italian culture. Progressive and comprehensive review of Italian grammar. Expansion of vocabulary. Pre: 2106. (3H,3C)

3305,3306: INTRODUCTION TO ITALIAN LITERATURE IN CONTEXT
Overview of genres and themes of Italian literature from national unification to the present. Familiarizes students with the socio-historical context necessary to discuss and write critically about this literature. 3305 examines the period from unification until the end of World War II including representations of national identity at the time of unification and beyond, generic experimentalism, resistance and complicity in the Fascist era, social realities during World War II. 3306: examines the period from the end of World War II to the present including retrospective debates about historical eras, economic conditions and political responses, gender politics, the influence of specific historical migrations on literature. Taught in Italian. Pre: 3105 or 3106. (3H,3C)

3474: TOPICS IN ITALIAN CINEMA
Critical issues in the history of modern and contemporary Italy through cinema, with an emphasis on films produced in Italy that most reflect the nation, its culture and society, and its cinematic trends. Students will discuss and write about the cultural, intellectual, and historical contexts present in Italian cinematic works. Sample topics, depending on the given semester, include organized crime, immigration, the urbanization of Italy, and neorealism. Taught in English. May be repeated, with different content, for a maximum of 6 credit hours. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH

Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Undergraduate Course Descriptions (JPN)

1105-1106: ELEMENTARY JAPANESE
Fundamentals of the Japanese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Japanese. (3H,3C)

2105-2106: INTERMEDIATE JAPANESE
Emphasizes comprehension of written and spoken Japanese, communication in Japanese; study of some literature and culture of the Japanese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent. X-grade allowed. Pre: 1106. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105-3106: ADVANCED JAPANESE
3105: Practice in communication skills in Japanese both orally and writing, including review of grammar, directed composition and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers. Pre: 2106 for 3105; 3105 for 3106. (3H,3C)

3125-3126: JAPANESE FOR ORAL PROFICIENCY
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. 3125: Provides students with the ability to converse in every day Japanese conversation. Focus on everyday conversational skills including life topics, transactions, and Japanese media. Emphasis on appropriate body language and understanding of cultural, political, and religious knowledge. 3126: Provides students with the ability to converse in advanced and complex situations. Focus on formal conversations (honorific, humble, and extra-polite) and business Japanese. Not recommended for native speakers. Pre: 2106 for 3125; 3125 for 3126. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4104: JAPANESE ADVANCED GRAMMAR
Advanced Japanese grammar skills. Use of special verbs in honorific, extra-modest, and humble form. Analysis and writing of personal and professional texts. Question formation within larger sentences, naming items, using passive and passive-causative sentences. Development of the ability to read, write, and apply the use of 317 intermediate-level kanji in various contexts. Pre: 3106. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (KOR)

1105-1106: ELEMENTARY KOREAN
Introduction to speaking, listening, reading, and writing the Korean language. Emphasis on developing proficiency in practical language use, comprehension, and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: Transactions like asking directions, expressing personal preferences, or making purchases. (3H,3C)

Undergraduate Course Descriptions (LAT)

1105-1106: ELEMENTARY LATIN
Introduction to Latin, for development of reading ability. 1105: Introduction to the basics of the language and short readings of graded difficulty. 1106: Introduction to the basics of the language, continued, with introduction of selected passages from ancient Roman authors for reading, comprehension, and translation. (3H,3C)

2104: CICERO AND LIVY
A course in two major Latin prose authors. Review and refinement of the language is combined with an increasing attention to historical, cultural, linguistic and literary questions. May be repeated with different content for a maximum of 9 credits. Pre: 1106. (3H,3C)

2114: LATIN EPIC: VERGIL AND OVID
A course in two important Latin poets of the Age of Augustus with a view to increasing the students ability to understand and read Latin. Review and refinement of the language is combined with an increasing attention to historical, linguistic, cultural, and literary questions. May be repeated with different content for a maximum of 9 credits. Pre: 1106. (3H,3C)

2124: LATIN LYRIC: CATULLUS AND HORACE
Two important Latin poets of the Late Republic. Review and refinement of the language is combined with an increasing attention to historical, linguistic, cultural, and literary questions. May be repeated with different content for a maximum of 9 credits. Pre: 1105, 1106. (3H,3C)

2134: LATE MEDIEVAL LATIN
Post-classical Latin, from Augustine and Boethius through the Middle Ages, Renaissance, and the Modern Age. Review and refinement of the language is combined with an increasing attention to historical, cultural, linguistic and literary questions. May be repeated with different content for a maximum of 9 credits. Pre: 1105, 1106. (3H,3C)

2964: FIELD STUDY

Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: READINGS IN LATIN LITERATURE
A variable content course devoted to the study of major Latin texts not offered in the 2000-level courses. Emphasis is on content, style, and context. May be repeated for credit with different content. Two 2000-level courses in Latin or equivalent proficiency required. Writing Intensive. (3H,3C)

4004: DIRECTED STUDIES IN LATIN PROSE COMPOSITION
Application of Latin grammar structure to the translation of English into Latin. Original compositions are written in Latin. (Will be offered during the academic year whenever there is sufficient enrollment and available staffing). One 3000-level course in Latin required. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Undergraduate Course Descriptions (PORT)

1105-1106: BEGINNING CONVERSATIONAL PORTUGUESE
Essential vocabulary and structures of the Portuguese language as spoken in Brazil; emphasis on active spoken and written use of the language for practical daily purposes. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (RUS)

1105-1106: ELEMENTARY RUSSIAN
Fundamentals of grammar, pronunciation, conversation, and reading. Respond to simple questions using appropriate grammar and syntax, participate in conversation about family, school, everyday situations, etc., write in cursive, and read adapted texts. 1105: Grammar and conversation; 1106: Grammar, conversation, and reading. (3H,3C)

1114: ACCELERATED ELEMENTARY RUSSIAN
Proficiency-oriented approach to elementary Russian, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 1105 and 1106. (6H,6C)

2105-2106: INTERMEDIATE RUSSIAN
Grammar, reading, conversation, and composition. Emphasizes comprehension of written and spoken Russian. Pre: 1106. (3H,3C)

2114: ACCELERATED INTERMEDIATE RUSSIAN
Proficiency-oriented approach to intermediate Russian for learners who wish to progress rapidly through the intermediate stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 2105 and 2106. Pre: 1106 or 1114. (6H,6C)

2734: INTRODUCTION TO RUSSIAN CULTURE AND CIVILIZATION
Introduction to Russian Culture and Civilization. Interactions between major political and historical events, social and artistic movements in Russia. Russian literature, art, architecture, film, and theatre in the context of Russian cultural history. Aesthetic and rhetorical strategies. Interpretation of intercultural experiences from different vantage points. Taught in English. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105,3106: GRAMMAR, COMPOSITION AND CONVERSATION
Detailed study of grammar. Practice in written and oral expression in Russian on a variety of topics. Supplementary readings to emphasize application of grammatical principles. 3105 includes a rapid grammatical review. Pre: 2106. (3H,3C)

3124: RUSSIAN FOR ORAL PROFICIENCY
Devoted to the acquisition of measured levels of proficiency in speaking and understanding spoken Russian. Content-based instruction in small groups. For students who would like to achieve an oral proficiency rating comparable to "Intermediate-high" on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or "S-1+" on the Foreign Service Institute (FSI) scale. Admission by oral exam required. Taught alternate years. Pass/Fail only. (3H,3C)

3304: SURVEY OF NINETEENTH-CENTURY RUSSIAN LITERATURE IN TRANSLATION
Masterpieces of Russian fiction and poetry written between 1815 and 1881. Romantic poetry of the early nineteenth century and traces the beginnings of Russian prose from early short stories to the rise of the novel as the dominant literary form in the second half of the century. History and politics to theological and philosophical issues in various works. Methods, terminology and practice of literary analysis. Taught in English. Pre: ENGL 1106 or ENGL 1204H. (3H,3C)

3314: SURVEY OF TWENTIETH-CENTURY RUSSIAN LITERATURE IN TRANSLATION
Masterpieces of the twentieth-century Russian literature. Symbolist, Acmeist and Futurist poetry, modernist and postmodernist prose such as Mikhail Bulgakov's "The Master and Margarita", and Viktor Pelevin's "Life of Insects." Terminology, practice, and standard methods of literary analysis. Interactions between major political events, social and literary movement. Aesthetic and rhetorical strategies. Taught in English. Pre: ENGL 1106 or ENGL 1204H. (3H,3C)

3424 (ENGL 3424): TOPICS IN RUSSIAN LITERATURE IN ENGLISH
Variable-content course devoted to the study of Russian literary classics. From general surveys of nineteenth- and twentieth-century literature to more intensive study of the works of a single major author. Aesthetic and rhetorical strategies. Interactions between literary movements and political, historical, and cultural events. May be repeated once with different content for a maximum of 6 credits. Readings and lectures in English. No knowledge of Russian required. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

3434 (ENGL 3434): THE WORKS OF VLADIMIR NABOKOV
Readings in major works of Vladimir Nabokov from the 1920s through the 1970s. Aesthetic and rhetorical strategies, literary analysis, major themes, immigration and cultural knowledge. Taught in English. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4204: TOPICS IN RUSSIAN CULTURE AND CIVILIZATION
Specific topics in Russian culture and civilization. Variable content. May be repeated for credit with different content. Pre: 3106. (3H,3C)

4304: STUDIES IN RUSSIAN LITERATURE
Selected masterpieces of Russian literature, read in original. Lectures and discussions in Russian. May be repeated for credit with different content. Pre: 3106. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (SPAN)

1105-1106: ELEMENTARY SPANISH
Fundamentals of grammar, composition, and oral skills. Readings carefully selected for comprehension and simple conversation. 1105 for students with no high school Spanish; 1106 for students who have completed 1105 or who have less than three years of high school Spanish. (3H,3C)

1114: ACCELERATED ELEMENTARY SPANISH
Condenses SPAN 1105 and 1106. Proficiency-oriented approach to elementary Spanish, designed for learners with some prior experience in the language or for those who wish to progress rapidly through the beginning stages of language learning. Supplemented with a self-instructional electronic component. Meets University and college foreign language requirement. SPAN 1114 duplicates SPAN 1106. (3H,2L,4C)

2105-2106: INTERMEDIATE SPANISH
Review of grammar with increasing emphasis on reading, writing, and oral communication. X-grade allowed. Pre: 1106 or 1114 for 2105; 2105 for 2106. (3H,3C)

2154 (HORT 2154): SPANISH FOR THE GREEN INDUSTRY
Dialogue-based language course focusing on the vocabulary and grammatical structures pertaining to Green and Agricultural Industry jobs. Includes vocabulary and context specific to jobs and workers in greenhouse, nursery, turf and landscape environments. Spanish culture is included throughout the course along with grammar and structure. Prior study in Spanish is helpful but not required. (3H,3C)

2744: TOPICS IN SPANISH CULTURE
Examines fundamental concepts related to Spanish culture within a specific historical and geographical context. Interprets cultural artifacts of the period across selected genres, including drama, poetry, film, and/or art. Analyzes how cultural identity is constructed by multiple and diverse disciplinary perspectives and in response to global challenges and opportunities. Taught in English. Repeatable with different topics for a maximum of 6 credits. (3H,3C)

2754: TOPICS IN SPANISH AMERICAN CULTURE
Examination of fundamental concepts related to Spanish American culture in variable historical and geographical contexts through the study of one or more of the following: narrative; essay; drama; poetry; film; and art. Emphasis on the interpretation and analysis of cultural texts and other creative artifacts in the context of key historical and political events, in order to understand shifting concepts of cultural identity, advantages and challenges of diversity and inclusion, and global challenges and opportunities in the human world. Taught in English. Course may be repeated, with different topics, for a maximum of 6 credits. (3H,3C)

2764: INTRODUCTION TO LATINO AMERICAN STUDIES
Introduction to interdisciplinary field of Latino American Studies. Exploration of debates and problems of Latin American and Latina/o history and culture. Examination and analysis of transnational, social, and cultural trends. Emphasis on connections between United States and Latin America, and local and regional Latina/o communities. In English. (3H,3C)

2774: MINORITY LANGUAGES IN THE SPANISH-SPEAKING CONTEXT
Examination of language policies and practices with regard to minority languages across the Spanish-speaking context, histories of minority languages in Spanish-speaking areas, and the current socio-political situations of these languages and their speakers. Exploration of issues concerning linguistic rights, such as access to education, economic opportunities, and political status; analysis of the implications of restrictions on minority groups' linguistic rights. Discussion of why some minority-language speakers have been more successful in their language conservation or revitalization efforts than others. Taught in English. Does not count toward the Spanish major or minor. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105-3106: GRAMMAR, COMPOSITION AND CONVERSATION
Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish. X-grade allowed. Pre: 2106 for 3105; 3105 for 3106. (3H,3C)

3125-3126: SPANISH FOR ORAL PROFICIENCY
For acquisition of measured levels of proficiency in speaking and understanding spoken Spanish. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to "Intermediate-high" on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or "S-1+" on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to "Advanced" on the (ACTFL-OPI) or a "2" on the FSI scale. Admission by oral exam. Pass/Fail only. (3H,3C)

3304: INTRODUCTION TO HISPANIC LITERATURE
Introduction to Hispanic literary genres (poetry, narrative, essay, and drama) through analysis and discussion of the main historical, political and cultural concepts of Hispanic Literature from Spain and Latin America from the Middle Ages to the present. Identification of issues of diversity (race, gender, and social class) in the Spanish-speaking world. Methods, terminology, and practice of literary analysis. Taught in Spanish. X-grade allowed. Pre: 3106. (3H,3C)

3404: EARLY PENINSULAR CULTURE AND LITERATURE
Examination of the culture and literature of Spain from the 9th century to the 18th century, including historical documents, narrative, poetry, theatre, and art. Emphasis on the interpretation and analysis of cultural texts in the context of key historical and political events. Examination of multiple levels of cultural identity, including advantages and challenges of diversity, found within the Iberian peninsula during that time frame. Reflection on similarities of intercultural exchange in medieval Spain and our own age. Taught in Spanish. Pre: 3304. (3H,3C)

3414: MODERN PENINSULAR CULTURE AND LITERATUREM
Examination of the culture and literature of Spain from 1700 to the present, including narrative, poetry, theatre, film, and art. Emphasis on the interpretation and analysis of cultural texts in the context of key historical and political events, in order to understand shifting concepts of cultural identity and advantages and challenges of diversity. Taught in Spanish. Pre: 3304. (3H,3C)

3444: EARLY SPANISH-AMERICAN CULTURE AND LITERATURE
Exploration of the cultural development of Spanish America from the pre-Hispanic era, the Encounter, the three hundred years of colonialism to Independence from Spain and nation- building in the 19th century; analysis of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, art, architecture and music; interpret intercultural experiences from one's own worldview. Taught in Spanish. Pre: 3304. (3H,3C)

3464: MODERN MEXICAN AND CENTRAL AMERICAN CULTURE AND LITERATURE
Exploration of the civilization, culture, and literature of Mexico and Central America, spanning the 19th century post-independence period to the present; analysis of literary and cultural texts within the historical, political, and social context in which they were created; interpretation of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Taught in Spanish. Pre: 3304. (3H,3C)

3474: MODERN SPANISH-CARIBBEAN CULTURE AND LITERATURE
Exploration of the civilization, culture, and literature of the Spanish Carribbean, spanning the 19th century post- independence period to the present; analysis of literary and cultural texts within the historical, political, and social context in which they were created; interpretation of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Taught in Spanish. Pre: 3304. (3H,3C)

3484: MODERN ANDEAN AND SOUTHERN CONE CULTURE AND LITERATURE
Exploration of the civilization, culture and literature of the Andean and Southern Cone regions of South America, spanning the 19th century post-independence period to the present; examination of literary and cultural texts with the historical, political, and social context in which they were created; study of canonical as well as non-canonical texts, from both "high" and "popular" culture, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Tuaght in Spanish. Pre: 3304. (3H,3C)

3494: INTRODUCTION TO HISPANIC LINGUISTICS
Introduction to fundamental concepts of Hispanic linguistics. Examination of linguistic properties in Spanish (e.g.,morphology, syntax, and semantics/pragmatics). Exploration of context-appropriate language use. Interpret experiences with language from different perspectives. Examination of complexities of cross-cultural communication. In Spanish. Pre: 3304. (3H,3C)

3514: SPANISH FOR THE MEDICAL PROFESSIONS
Specialized course applying knowledge of the Spanish language and its culture to the medical professions. Contextualized use of specific vocabulary, idiomatic expressions, and cultural practices in real-world situations. Taught in Spanish. Pre: 3304. (3H,3C)

3524: INTRODUCTION TO SPANISH TRANSLATION
Introduction to the translation of various types of texts, such as literature, business correspondence, commercial advertising, and legal documents. Includes translation from English to Spanish and from Spanish to English, as well as a thorough review of Spanish grammar and idiomatic language. Taught in Spanish. Pre: 3304. (3H,3C)

3534: SPANISH FOR THE BUSINESS PROFESSIONS
Vocabulary, idiomatic expressions, business letters, and customs common to the Spanish-speaking commercial milieu. For students who would like to apply their language knowledge to careers in the business world. In Spanish. Pre: 3304. (3H,3C)

3544: SOUNDS OF SPANISH
Provides students with an overview of phonetics and phonology in Spanish and familiarizes students with the articulatory descriptions of vowels and consonants of Spanish. Compares and contrasts the sound systems of Spanish and English. Analyzes the sound system using theories and methods in linguistics. Explores the social meaning of the phonetic variation that exists throughout the Spanish-speaking world. Taught in Spanish. Pre: 3304. (3H,3C)

3554: TEACHING SPANISH
Examination of theories and approaches to second-language and heritage-language learning and teaching. Discussion of technological resources and authentic materials that promote language teaching and individual differences that affect language learning. Analysis of pedagogical materials for the Spanish-language classroom. Hands-on experience with lesson-plan design for teaching Spanish. Taught in Spanish. Pre: 3304. (3H,3C)

3564: COMMUNITY THROUGH SERVICE: LATINO NRV
A service-learning course in Spanish. Exploration of Latino cultures in the U.S.; weekly service with members of local Latino communities who have requested help; reflection on community work and student citizenship; exploration of cultural factors involved in the construction of community, including the challenges of immigration, multiculturalism, and multilingualism within the U.S.; analysis of literary

readings, films, and works of art from U.S. Latino communities; discussion of readings on Hispanic migrations and border studies, as well as articles on social privilege, service-learning, education, health care, language, and language learning. Taught in Spanish. Pre: 3304. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4104: ADVANCED GRAMMAR AND STYLE
Analysis of and practice with advanced grammatical and stylistic concepts, including idiomatic and colloquial usage. Intended to help advanced students achieve high levels of proficiency in writing and speaking Spanish. X-grade allowed. Pre: 3106. (3H,3C)

4114: TOPICS IN SPANISH LINGUISTICS
Variable content course that surveys linguistic concepts and methods as related to the Spanish language. Topics may include the study of the phonology, morphology, syntax, and semantics of Spanish; the pedagogical application of these language systems; the psychological and social context of language; and the development of Spanish from its origins to its modern form. May be repeated for credit with different content. Pre: 3494 or 3544. (3H,3C)

4124: SPANISH TRANSLATION: THEORY AND TECHNIQUE
Introduction to translation theories and application of these theories to different types of texts, including literature, business correspondence, commercial advertising, and legal documents. Includes translation from English to Spanish and from Spanish to English, as well as a thorough review of Spanish grammar and idiomatic language. Pre: 3524. (3H,3C)

4304: TOPICS IN EARLY MODERN LITERATURE AND CULTURE
Variable topics in Hispanic and/or Latin American literature and culture of the Early Modern period. Texts and/or cultural artifacts selected for aesthetic value, historical importance and thematic significance. Related scholarly criticism representing a variety of approaches. Emphasis on historical, social and cultural context. May be repeated twice for credit with different content. Taught in Spanish. Pre: 3404 or 3414 or 3444 or 3464 or 3474 or 3484. (3H,3C)

4314: STUDIES IN 18TH AND 19TH CENTURY LITERATURE
A variable content course devoted to Hispanic literature of the 18th and 19th centuries. The texts selected are studied not only for their aesthetic value but also in terms of their historical and cultural significance. May be taken twice for credit with different content. Taught alternate years. I Pre: 3414 or 3404 or 3444 or 3464 or 3474 or 3484. (3H,3C)

4324: STUDIES IN 20TH AND 21ST CENTURY HISPANIC LITERATURE
A variable content course devoted to Hispanic literature of the 20th and 21st centuries. Offers an in-depth literary exploration of a significant historical period, cultural movement, theme, or genre. Focuses on literary and cultural analysis from a variety of perspectives. Practices advanced Spanish oral and writing skills. Examines texts that have aesthetic value and historical and cultural significance. May be taken up to three times for credit with different content. Pre: 3404 or 3414 or 3444 or 3464 or 3474 or 3484. (3H,3C)

4334: SPECIAL TOPICS IN HISPANIC LIFE, LITERATURE, AND LANGUAGE
Broad central themes of Hispanic culture as manifested in creative and historical literature, music, art, film, etc., or in language, such as the history of the Spanish language, translation techniques, or the staging of dramatic works in Spanish. Historical and/or national boundaries are crossed whenever the nature of the topic permits. May be repeated for credit with different content. Taught alternate years. X-grade allowed. Pre: 3404 or 3414 or 3444 or 3464 or 3474 or 3484. (3H,3C)

4344: HISPANIC LITERATURE AND THE REPRESENTATION OF HISTORY
Focuses on the relationship between history and literature in the Hispanic world through an interdisciplinary lens. Examines different geographical regions of the Hispanic world, theoretical readings,

and the ways that authors have used various literary styles to portray, re-write, subvert, and even contradict their countries' official history. Examines texts that have aesthetic value and historical and cultural significance. Practices advanced Spanish oral and writing skills. This variable topics course may be repeated up to three times if topics are different. Pre: 3404 or 3414 or 3444 or 3464 or 3474 or 3484. (3H,3C)

4794: SENIOR TUTORIAL IN SPANISH STUDIES
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. May be taken twice for credit with different content. Must be pre-arranged three weeks before end of previous semester. One 4000 level Spanish course required. Restricted to Seniors. Restricted to Spanish majors. Consent of Spanish Section required. (1H,1C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4964H: FIELD STUDY
Honors Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Forest Resources and Environmental Conservation

University Distinguished Professor: H. E. Burkhart
Alumni Distinguished Professor: J. R. Seiler
Julian N. Cheatham Professor: G. S. Amacher
Honorable Garland Gray Professor: T. R. Fox
Professors: W. M. Aust, R. B. Hull, S. P. Prisley, J. Sullivan, and R. H. Wynne
Associate Professors: M. C. Bolding, A. M. Brunner, C. A. Copenheaver, S. D. Day, J. A. Holliday, J. A. McGee, J. F. Munsell, P. J. Radtke, M. J. Stern, B. D. Strahm, V. A. Thomas, and P. E. Wiseman
Assistant Professors: S. M. Barrett, K. M. Cobourn, J. A. Holliday, D. L. McLaughlin, M. G. Sorice, and R.Q. Thomas
Adjunct Faculty: C. B. Anderson, S. W. Bailey, G. M. Busby, D. C. Chojnacky, J. W. Coulson, A. J. Finkral, J. D. Knoepp, W. A. Lakel, C. A. Maier, J. L. Marion, R. Rubilar, E. B. Schilling, D. J. Soucek, E. B. Sucre, J. A. Westfall, and James Westlake
Courtesy Appointments: J. R. Harris (Horticulture), P. A. Miller (Landscape Architecture), and S. M. Salom (Entomology)

Web: **www.frec.vt.edu**

Environmental Informatics

Environmental Informatics applies information science to the management of natural resources. It includes aspects of geographic information, mathematical and statistical modeling, remote sensing, database management, knowledge integration, and decision making.

Forest Resource Management

The Forest Resource Management option emphasizes the biology, policy, and management skills needed to ensure the sustainability of the many renewable forest resources on which society depends. Graduates manage the forested landscape to provide society a renewable supply of wood and paper products along with clean water, recreation opportunity, wildlife habitat, and environmental quality.

Forest Operations and Business

Forest Operations and Business graduates are well prepared for careers in private industry emphasizing harvesting and reforestation operations. Forest Operations and Business specializes beyond the Forest Resource Management option by emphasizing the operations side of forestry along with landowner assistance and management skills for people and business.

Environmental Resource Management

The Environmental Resource Management major develops professionals who tackle a variety of environmental issues in the forested landscape. The foundation of this area of study is sustainability with additional emphasis placed on water resources, forest soils, environmental policy, and wildlife management.

Urban Forestry

The Urban Forestry option produces graduates who can deal with the ecological and biological characteristics of the forest in an urban environment, as well as the managerial and political context within which forest management takes place. Special education, training, and experience are necessary to address the many and complex biological, social, economic, and political issues that are part of the urban forest setting.

Conservation and Recreation Management

Conservation and Recreation Management blends natural sciences, resource management, and social sciences disciplines and topics. Graduates provide high quality recreation experiences to ever increasing numbers of recreationists while protecting the natural environment on which these experiences depend. Emphasis is on the human dimensions of natural resource management.

Environmental Education

Environmental Education prepares students to teach in elementary schools. It is intended as a feeder into the Masters in Education at Virginia Tech, which provides necessary licensure. With proper planning, the Masters degree can be completed in one year.

Water: Resources, Policy, and Management

The Water: Resources, Policy, and Management degree addresses the protection and development of water resources by providing the interdisciplinary training required to meet water challenges and

opportunities now and in the future.

Undergraduate Course Descriptions (FREC)

1004 (GEOG 1084): DIGITAL PLANET
Exploration of innovative geospatial technologies and their impact on the world around us, including how humans interact with the environment and each other. Roles of location-based services, global positioning systems, geographic information systems, remote sensing, virtual globes and web based mapping for environmental applications. Skills and techniques for spatial thinking and environmental decision-making. Ethical implications of the use of geospatial technologies, data, and computational approaches. (3H,3C)

1044: INTRODUCTION TO ENVIRONMENTAL INFORMATICS
Application of information science to environmental management. Role of information science, mathematical and statistical modeling, geospatial technology, database management, knowledge integration, and decision science in environmental decision-making. Skills and techniques required to assist scientists and managers with the challenges of collecting, collating, archiving, modeling, analyzing, visualizing, and communicating information in support of natural resource management. (3H,3C)

2004: FOREST ECOSYSTEMS
Introduction to forest ecosystem ecology. Global forest cover, types, distribution, and change. Relationships among forest structure, function, and biodiversity. Interactions among rock, soil, water, air, and the organisms that define and inhabit forests around the world. Energy, water, carbon, and nutrient fluxes from leaf to global scales. Connections among forests, society, and global change. Capacity of forests to sustainably provide ecosystem services. (3H,3C)

2114: ECOLOGY OF APPALACHIAN FORESTS
Introduction to the natural history, tree biology, tree identification, forest ecology, management and forest types of the Appalachian region. Contemporary issues related to forest functions will be discussed including carbon storage, climate change, invasive forest species, wildlife management, fire, biofuels, agroforestry, urban forests, ecosystem restoration, clean water, recreation, and use of renewable resources. (3H,3C)

2124: FORESTS, SOCIETY & CLIMATE
Role of forest ecosystems on the global carbon cycle, climate, biodiversity and economies. Anthropogenic impacts on forest ecosystems and their ecological function in the face of changing climate. Regional and cultural implications for the state of the forests and deforestation-related policy. Climate-related threats to global forests, including loss of biodiversity, deforestation, forest fires, and invasive species. Sustainable forest management for anticipated future scenarios. (3H,3C)

2134 (HORT 2134): PLANTS AND GREENSPACES IN URBAN COMMUNITIES
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales. (3H,3C)

2214: INTRODUCTION TO LAND AND FIELD MEASUREMENTS
Measurement of land and field attributes including geographic position, land distance, direction, area, slope, elevation and boundary attributes. Use and development of maps used in natural resource applications. Use of global positioning systems and geographic information systems in the acquisition and management of land and field measurements. Assessment of vegetation attributes with field plots. Use of computer software to manage and analyze data and present results. Pre: MATH 1025 or MATH 1225 or MATH 1525. Co: 2324. (2H,3L,3C)

2254: ARBORICULTURE FIELD SKILLS
Field observation, discussion, and practice of skills employed in the management of urban landscape trees. Hands-on experience with tree pruning, removal, pest control, fertilization, cabling/bracing, lightning protection, and climbing. Emphasis on arborist safety, professional ethics, and best management

practices. Guest instruction provided in part by professionals working in the tree care industry. Pass/Fail only. (3L,1C)

2314: FOREST BIOLOGY AND DENDROLOGY
Introduction to the botany, physiology, genetics and silvics of important forest trees of North America. Pre: BIOL 1006 or BIOL 1106. Co: 2324. (2H,2C)

2324: DENDROLOGY LABORATORY
Field identification of trees of North America with particular emphasis on trees native to the Eastern United States. (3L,1C)

2414: FIELD EXPERIENCE IN FOREST RESOURCES AND ENVIRONMENTAL CONSERVATION
Field exercises to develop skills needed to sustainably manage forest and environmental resources including navigation and mapping, inventory of timber and non-timber resources, soil and water conservation, forest and recreation management, forest operations and timber harvesting. (6L,2C)

2514: WILDLAND FIRE: ECOLOGY AND MANAGEMENT
Provide students with basic knowledge on how: fire has an impact on forest environments; the environment and weather influence fire behavior; wildland fires are suppressed; and fire is used as a land and vegetation management tool. The course will also provide students with the knowledge and training to qualify as a basic wildland firefighter (FFT2-Red Card). Extended laboratory sessions will provide practice in fire behavior prediction, prescribed burning techniques, and fire control methodology. Pre: BIOL 1014 or BIOL 1105 or BIOL 1106. (2H,3L,3C)

2554 (LAR 2554) (NR 2554): LEADERSHIP FOR GLOBAL SUSTAINABILITY
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management. (3H,3C)

2614: HUMAN-ENVIRONMENT SYSTEMS
Social and ecological dynamics of human-environment systems. Effect of complex environmental problems on ecosystems and human well-being. Introduction to systems thinking. History, philosophy, and application of decision making in the field of natural resource management. Pre: Sophomore standing. (3H,3C)

2784 (SBIO 2784): GLOBAL FOREST SUSTAINABILITY
A socio-economic approach to examining the management and use of the world’s forests, enhance knowledge of global forest resources and products, and understand the roles and relationships of key stakeholders. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3004: ENVIRONMENTAL INFORMATICS
Applications of the analysis and modeling of large environmental datasets at multiple spatial-temporal scales to study environmental issues of societal importance. Acquisition, analysis, visualization, and

storage of environmental data. Ethics and methods of data curation, quality control, and sharing. Sophomore standing required. Foundational knowledge in quantitative and computational thinking expected. (3H,3C)

3104 (WATR 3104): PRINCIPLES OF WATERSHED HYDROLOGY
Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earth's surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing Pre: MATH 1206 or MATH 1226 or MATH 2015 or MATH 1026. (3H,3C)

3214: FOREST BIOMETRICS
Statistical, mathematical and computer tools for collecting and analyzing data used to make inference or decisions in applications of forest ecosystem science and management. Principles and practices of forest inventory and probability-based sampling. Derivation of volume and weight equations for standing trees. Measures of stand density and site quality. Forest growth and yield modeling. Organization, summary and conveyance of information derived from the data-driven applications into visual, written, and spoken materials of presentation. Pre: (2214 or FOR 2214), (MATH 2015 or MATH 1026). (3H,3C)

3224: FOREST MEASUREMENTS FIELD LABORATORY
Field practice and computer analysis for collecting and analyzing survey data for use in forest management. Forest inventory and probability-based sampling, stratified sampling, double sampling, regression, and census-based sampling applications. Computer and geospatial tools for analyzing field data. Field assessment of tree and log contents, stand density, and site index. Collection and analysis of growth and yield data. Pre: (2214 or FOR 2214), (FREC 2414 or FOR 2414). (3L,1C)

3314: FOREST ECOLOGY AND SILVICS
Environmental factors affecting the establishment, growth, and development of forests; silvical characteristics of trees; forest community structure and function; forest ecosystem analysis. Pre: (2314 or FOR 2314), (FREC 2214 or FOR 2214). (2H,4L,3C)

3324: SILVICULTURE PRINCIPLES AND APPLICATIONS
Theory and practices involved in controlling forest establishment, composition, and growth are developed in a regional context. Formulation of silvicultural systems and the study of reproduction methods, site preparation, intermediate stand manipulations, and reforestation operations. Pre: 3314 or FOR 3314. (3H,4L,4C)

3344: FOREST FIELD STUDIES
Field observations and discussion of current forestry operations and practices. Junior standing required. A-F only. Pre: 2214 or FOR 2214. (3L,1C)

3354 (HORT 3354): TREES IN THE BUILT ENVIRONMENT
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment. Pre: (2314 or FOR 2314 or BIOL 2304 or HORT 2304), (FREC 2324 or FOR 2324 or HORT 3325 or HORT 3326). (3H,3C)

3364: ENVIRONMENTAL SILVICULTURE
Application of ecological principles that determine how forests regenerate following disturbances, grow, develop, and change through time. Sustainable management of forests to meet the competing demands for products and environmental services placed on forests by society. Development of silvicultural regimes that meet multiple objectives including wildlife habitat, carbon sequestration, ecosystem restoration, clean water, aesthetics, recreational opportunities, timber and non-timber forest products. Pre: 2324 or FOR 2324. (3H,3C)

3454: TREES IN THE BUILT ENVIRONMENT LAB
Hands-on experience in the cultivation, conservation, and management of landscape trees in human-

dominated environments along the urban to rural gradient. Field exercises in tree inventory, appraisal, disorder diagnosis, planting, pruning, and protection. Emphasis on use of scientific methods and best management practices to ensure tree health, safety, and functionality for the benefit of people and the environment. Methods of communicating technical information and management recommendations for landscape trees through written media. Co: 3354. (3L,1C)

3524: ENVIRONMENTAL INTERPRETATION
Interpretation theory and techniques; program planning and evaluation; role of interpretation in enhancing visitor experiences and protecting park resources. Pre: 2554 or FOR 2554. (2H,3L,3C)

3544: OUTDOOR RECREATION PLANNING & MANAGEMENT
Planning and management of nature-dependent outdoor recreation. History, philosophy and benefits of nature-dependent outdoor recreation. Environmental and social impacts of recreational uses. Techniques to manage visitor impact. Pre: Junior standing. Pre: 2554 or FOR 2554. (3H,3C)

3574: ENVIRONMENTAL EDUCATION SERVICE LEARNING
Introduction to key concepts in environmental education and teaching skills through lecture, discussion, service learning, and reflection. Training in internationally recognized environmental education curricula (e.g. Project Learning Tree, Project Wet), in class management and organization skills and in theory relevant to both teaching and learning. Students develop and conduct after school environmental education programs at local elementary schools (2H,3L,3C)

3604: CLIMATE SCIENCE
Physical and biological principles that govern Earth's climate with applications to natural resource management. Mechanisms explaining the causes of past and future climate change. Concepts of system dynamics as applied to the analysis of the climate system. Current and future effects of climate on ecosystem functioning and the associated provision of natural resources. Junior Standing. Pre: MATH 1026 or MATH 1206 or MATH 1226 or MATH 2015. (3H,3C)

3714: FOREST HARVESTING
Principles and application of forest harvesting. Terminology, phases, function, and the interrelationships of people, money, machines, and environment. Pre: 2214 or FOR 2214. (2H,3L,3C)

3724: FOREST BOUNDARIES AND ROADS
Application of basic land surveying and forest measurement techniques to the location, establishment, and maintenance of forest boundaries and roads. Consideration of stream crossings, best management practices, and costs. Pre: 2214 or FOR 2214. (2H,3L,3C)

3734: TIMBER PROCUREMENT
Analysis of the U. S. forest industry raw material supply process with emphasis on the evolution and dynamics of timber procurement systems and strategies. (2H,2C)

3754 (WATR 3754): WATERSHEDS AND WATER QUALITY MONITORING
Delivery of water quality constituents from watersheds to water bodies (streams, lakes, and estuaries). Field monitoring methods to assess watershed drivers and how they affect water quality and aquatic ecosystem condition. Linkages among water quality, watershed characteristics, land use and management, and climate. Design of watershed monitoring programs to guide watershed management for protecting water quality and ecological condition of aquatic systems. Pre: (BIOL 1106 or BIOL 1006), CHEM 1035, (FREC 2004 or FOR 2004 or FREC 2114 or FOR 2114 or FREC 3314 or FOR 3314 or BIOL 2804 or ENSC 3604). (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3964: INTERNSHIP THROUGH DIRECTED FIELD STUDY
Variable credit course.

4014 (NR 4014): NATURAL RESOURCES ECONOMICS
Examination of domestic and international natural resource use, exploitation, and degradation problems,

with special focus on use of economics to understand why potential overuse of natural resources exists, and what policy options are available to correct these problems and ensure sustainable natural resource use over time. Water, forests, fisheries, land and exhaustible resources. Permission of instructor may be substituted for the pre-requisite. Pre: ECON 2005 or AAEC 1005. (3H,3C)

4114: INFORMATION TECHNOLOGIES FOR NATURAL RESOURCE MANAGEMENT
An introduction to computer information systems used in natural resources management. Course will introduce students to the theory and applications of database management systems (DBMS) and geographic information systems (GIS). Uses, challenges, and limitations of these technologies in natural resource management applications will be discussed. Students will receive extensive hand-on instruction in the use of current software packages for DBMS and GIS. Pre: 2214 or FOR 2214 or GEOG 2314. (2H,3L,3C)

4214: FOREST PHOTOGRAMMETRY AND SPATIAL DATA PROCESSING
Films, filters and camera photogeometry; scale; measurement estimation; image processing; flight planning and photo acquisition; geographic information systems; spatial data analysis techniques and applications. Senior standing required. (2H,3L,3C)

4324 (FIW 4324): GENETICS OF NATURAL AND MANAGED POPULATIONS
Introductory genetics with an emphasis on evolutionary processes relevant to natural and managed populations of both plant and animal species. Traditional and modern genetics, including quantitative and population genetics, molecular evolution, genomics, and biotechnology. Pre: BIOL 1105, BIOL 1106, (STAT 3005 or STAT 3615 or FREC 3214 or FOR 3214). (3H,3C)

4334 (CSES 4334): PRINCIPLES AND PRACTICE OF AGROFORESTRY
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects. (3H,3C)

4354: FOREST SOIL AND WATERSHED MANAGEMENT
Properties and processes of soil and water in forests. Emphasis on management for the delivery of ecosystem services at local to global scales. Includes analysis and interpretation in field and laboratory. Pre: CSES 3114 or FREC 2004 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134. (2H,3L,3C)

4364: ADVANCED SILVICULTURE AND FOREST VEGETATION MANAGEMENT
Advanced topics in silviculture with an emphasis on species silvical differences; forest vegetation management and control, herbicides used in forestry, their chemistry, toxicology, application technology; environmental considerations; tree improvement, individual tree growth, and stand dynamics as affected by intermediate silvicultural operations; implications of atmospheric deposition. Pre: 3324 or FOR 3324. (3H,3C)

4374: FORESTED WETLANDS
Classifications, jurisdictional delineation, and management options of forested wetlands. Relationship of hydrology, soils, and vegetation to ecosystem processes, societal values, and management with regard to environmental and legal considerations and best management practices. Emphasis is on forested wetlands in the southern U.S., but national and international wetlands are included. Pre: CSES 3114 or CSES 3134. (3H,3C)

4414: ADVANCED WILDLAND FIRE MANAGEMENT
Impacts fire has on forest environments; how the environment influences fire behavior; how computer programs aid fire decision making; and how fire is used as a land and vegetation management tool. Influences of weather on fire behavior. The course will also provide students with the knowledge and training to qualify as an advanced wildland firefighter (Squad Boss) (FFT1 - Red Card) and a Virginia Certified Prescribed Burn Manager. Pre: 2514 or FOR 2514. (2H,3L,3C)

4424: FOREST RESOURCES ECONOMICS AND MANAGEMENT
Application of economics principles and tools to forest decision making from the individual tract to large

private and public holdings. Private and public landowner financial incentives and decisions, forest amenities, non-timber forest products, risk, multiple use, management and ownership trends, and sustainability are examined. Prerequisite course or consent of instructor. Pre: 3324 or FOR 3324 or FREC 3364 or FOR 3364. (3H,3C)

4434: NATURAL RESOURCE POLICY
Historical development of U.S. natural resource policy. Application of policy analysis tools to understand the factors driving natural resource policy formation at the federal, state, and local level. Evaluation of the effects of alternative policies on natural resource use and social wellbeing. Overview of existing natural resource policies with applications to forest and timber management, biodiversity, public lands, endangered species, and climate change mitigation and adaptation. Pre: NR 4014 or FREC 4424 or FOR 4424 or ECON 4014 or FREC 4014 or FOR 4014. (3H,3C)

4444: INTEGRATED FOREST MANAGEMENT PRACTICUM
Student teams apply accumulated discipline-oriented knowledge and techniques to a real forest resource management problem. A practicum in forest resource management and planning, applying multiple use concepts to solve a forest management problem. Senior standing required. Must be Forestry major. (1H,8L,3C)

4454: URBAN AND COMMUNITY FORESTRY
Ecological, socioeconomic, and technical aspects of planning, managing, and conserving urban forests. Historical, contemporary, and global context of urban forestry. Contributions of trees and associated greenspaces to urban sustainability and community well-being. Methods of urban forest assessment and valuation. Roles of government, private industry, and community stakeholders in shaping urban forests. Extensive experiential learning with field techniques and technology. Pre: Junior Standing. (2H,3L,3C)

4464 (AAEC 4464) (WATR 4464): WATER RESOURCES POLICY & ECONOMICS
Economic concepts to understand public and private decisions about water use. Current water policies and law. Analytical tools to evaluate policies and address management challenges. Water markets, climate change, and environmental flows. Pre: AAEC 1005 or ECON 2005. (3H,3C)

4514: FOREST AND TREE PEST MANAGEMENT
Identification and ecology of biotic and abiotic influences on forest and landscape tree health. Developing a theoretical and practical understanding for diagnosing and managing pests and stresses of trees in both the forest and landscape setting. Insects and diseases that attack trees. Pre: 3324 or FOR 3324 or HORT 3325 or HORT 3326. (2H,3L,3C)

4554 (BSE 4554) (HORT 4554) (LAR 4554) (SPIA 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: HORT 2134 or FREC 2134. (3H,3C)

4714: HARVESTING SYSTEMS EVALUATION
Principles and techniques for evaluating harvesting machines and systems design, application, productivity, and financial performance. Pre: (3714 or FOR 3714), (FREC 3734 or FOR 3734). (3H,3C)

4784: WETLAND HYDROLOGY AND BIOGEOCHEMISTRY
Water flows creating wetland hydrologic regime. Hydrologic controls on wetland processes. Linkages between hydrology and biogeochemical cycles. Carbon, nitrogen, phosphorus, and other element cycles within and across wetland boundaries. Field methods to assess hydrologic regime and biogeochemical cycles. Ecosystems services from hydrologic and biogeochemical processes. Applications of wetland hydrology and biogeochemistry in wetland restoration, delineation, and creation. Co: 4374 or FIW 4534 or CSES 4854 or ENSC 4854. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (WATR)

2004 (GEOG 2004): WATER, ENVIRONMENT, AND SOCIETY
Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on ethics and relationships between human needs for and effects upon water including: water quality, water treatment, and wastewater treatment; water for health, energy, and food; water management, laws, economics, and conflict; hydrometeorological hazards and climate change; and potential solutions for these and other critical water issues. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3104 (FREC 3104): PRINCIPLES OF WATERSHED HYDROLOGY
Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earth's surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing Pre: MATH 1206 or MATH 1226 or MATH 2015 or MATH 1026. (3H,3C)

3754 (FREC 3754): WATERSHEDS AND WATER QUALITY MONITORING
Delivery of water quality constituents from watersheds to water bodies (streams, lakes, and estuaries). Field monitoring methods to assess watershed drivers and how they affect water quality and aquatic ecosystem condition. Linkages among water quality, watershed characteristics, land use and management, and climate. Design of watershed monitoring programs to guide watershed management for protecting water quality and ecological condition of aquatic systems. Pre: (BIOL 1106 or BIOL 1006), CHEM 1035, FREC 2004 or (FOR 2004 or FREC 2114 or FOR 2114 or FREC 3314 or FOR 3314 or BIOL 2804 or ENSC 3604). (3H,3C)

4464 (AAEC 4464) (FREC 4464): WATER RESOURCES POLICY & ECONOMICS
Economic concepts to understand public and private decisions about water use. Current water policies and law. Analytical tools to evaluate policies and address management challenges. Water markets, climate change, and environmental flows. (3H,3C)

4614 (ALS 4614): WATERSHED ASSESSMENT, MANAGEMENT, AND POLICY
Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, FREC, GEOL, LAR, CSES, ENT, BIOL, GEOG, AAEC, UAP or equivalent. (2H,2C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Food Science and Technology

Head: J.E. Marcy
Professors: R.R. Boyer, S.E. Duncan, J.D. Eifert, J.E. Marcy, S.F. O'Keefe, S.S. Sumner and R.C. Williams
Associate Professors: D.D. Kuhn, and M.A. Ponder
Assistant Professors: C. Fernandez-Fraguas, H. Huang, J. Lahne, R. Ovissipour, A.C. Stewart, and L. Strawn
Research Faculty: E. Chang, M. Chase, J.A. Eifert, and B. Weirsema
Adjunct Faculty: H. Bruce, and A.M. Dietrich
Career Advisor:

Web: **www.fst.vt.edu**
E-mail: **fstinfo@vt.edu**

Overview

Food science benefits consumers every day with healthier diets, better tasting affordable foods, and increased food safety. In the Department of Food Science and Technology, you really do get to play with your food! Food Science is an exciting area that applies a blend of basic sciences such as biology, chemistry and physics with microbiology, biochemistry, mathematics and engineering to improve the taste, nutrition and value of the world's food supply. The Food Science and Technology curriculum includes hands-on experiences that supports classroom instruction with practical applications and creative opportunities for product development.

Demand for Food Science and Technology graduates has never been greater. Practically 100% of Virginia Tech's Food Science and Technology graduates have jobs in product development, research, sales and marketing, quality assurance, production management, analytical and technical services and regulatory affairs at graduation. Food processing is the largest industry in the United States. This industry employs nearly 2 million people and accounts for more than 16 percent of the country's gross national product. In a recent survey of U.S. Food Science programs, Virginia Tech ranked 6th nationally in placing Food Science B.S. graduates into graduate or professional schools.

The Virginia Tech Department of Food Science and Technology is the only food science department in Virginia. The program is recognized by the national Institute of Food Technologists (IFT) as having curricula and options that meet the "IFT Undergraduate Education Standards for Degrees in Food Science." Students enrolled in these programs are eligible to apply for IFT Scholarships. The Virginia Tech Food Science Club is a student chapter of the national IFT organization and houses the Product Development and College Bowl teams that permits students to meet professionals in the food industry, develop leadership skills and enhance their educational experience. Students have excellent opportunities for internships as an additional way to explore different facets of the food industry.

The Food Science and Technology building is home to a 5,000 square-foot processing pilot plant, a fully-equipped research winery, a cutting-edge high-pressure processing area as well as laboratories modernly equipped for chemical, physical and microbiological analysis of foods. Due to the department's success and growth we expanded to the Human and Agricultural Biosciences Building (HABB1) and the Integrated Life Sciences Building in the VT Corporate Research Park. HABB1 is, located across the street from our present building provides the department with additional laboratories, pilot plants, taste panel and food preparation facilities, conference rooms, graduate student research spaces and faculty and staff offices. In the Department of Food Science and Technology you may receive a Bachelor of Science in one of four options: Food Business, Food and Health, Science or Food and Beverage Fermentation.

The Department also offers a minor, as well as a double-major option in Food Science and Technology to students in all other colleges of the university. Students completing the Science or Food & Health option requirements will also be prepared for graduate schools and professional schools of pharmacy medicine, dentistry and veterinary medicine. Food Science and Technology students have the opportunity to participate in stimulating undergraduate research projects and internships.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (FST)

2014: INTRODUCTION TO FOOD SCIENCE
Fundamentals for food science and technology. Integration of basic principles of food safety, human nutrition, food spoilage, and sensory evaluation with the appropriate technology of food preservation and processing. (2H,2C)

2044 (IS 2044) (PSCI 2044): FOOD, WAR AND CONFLICT
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict. (3H,3C)

2244: TOPICS IN FOOD SCIENCE AND TECHNOLOGY
Variable topics in food science and technology such as emerging trends, challenges and regulatory policy. Qualitatively and quantitatively explore relevant and timely issues facing food systems. May be repeated for a maximum of six credits with different topics. Pre: Sophomore standing. Variable credit course.

2544 (HNFE 2544): FUNCTIONAL FOODS FOR HEALTH
Introduction to functional foods (foods with additional value beyond basic nutrition) including development of functional foods, novel sources, and traditional foods with value-added health benefit; regulatory issues; and media messages. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3024: PRINCIPLES OF SENSORY EVALUATION
Principles of sensory evaluation including theory, sensory physiology and psychology, experimental methods, applications, and statistical analysis. Pre: STAT 3005 or STAT 3615. (3H,3C)

3114 (HORT 3114): WINES AND VINES
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age. (3H,3C)

3124: BREWING SCIENCE AND TECHNOLOGY
Study of chemical reactions important in brewing of beer and hard cider. Effects of variations in malting, mashing, and other processing steps on characteristics and quality of beer; fruit sugar, acid and fermentation impacts on cider composition and quality. Investigation of reactions that cause flavor deterioration. (3H,3C)

3214 (APSC 3214): PRINCIPLES OF MEAT SCIENCE
Muscle biology and biochemistry, fresh meat processing, meat merchandising, processed meats, food safety, meat cookery, and regulations. Pre: ALS 2304, CHEM 1036. (3H,3C)

3514: FOOD ANALYSIS
Data analysis, sampling techniques, theory and practice of chemical and physical methods of food analysis for determination of food composition; application of analytical methods of quality control and food laws and regulations. Pre: STAT 3615, (CHEM 2535 or CHEM 2514). (3H,3L,4C)

3604 (BIOL 3604): FOOD MICROBIOLOGY
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Method to enumerate, identify, and characterize microorganisms in foods. Pre:

BIOL 2604, BIOL 2614. (3H,3L,4C)

4014: CONCEPTS OF FOOD PRODUCT DEVELOPMENT
Application to the food industry of principles and standard practices of research and product development; functionality of food ingredients; students will work in teams to design and develop a new food product. Pre: 3604. Co: 4504, 4405. (3H,3C)

4104: APPLIED MALTING AND BREWING SCIENCE
Chemistry, biochemistry, and processing aspects of malting and brewing operations in the production of beer. Barley, malting, hops, brewing operations, fermentation and finishing operations examined. Laboratory exercises focused on malting and brewing. With permission of department required. Pre: 3124, 4504. (2H,4L,3C)

4304: FOOD PROCESSING
Basic principles, unit operations, equipment in commercially important food processing applications; raw food materials and packaging; sanitation. Introduction to food regulations and standards. Pre: BIOL 2604, BIOL 2614. (3H,3L,4C)

4414: FERMENTATION PROCESS TECHNOLOGY AND INSTRUMENTATION
Process design considerations for food and beverage fermentations, and other industrial fermentation processes. Critical process parameters, and instrumentation for fermentation process monitoring. Hands-on process instrumentation for fermentation. Pre: 4504 or 3604. (1H,2L,2C)

4504: FOOD CHEMISTRY
Overview of the chemical and functional properties of food components including major (water, proteins, carbohydrates, enzymes and lipids) and minor (vitamins, minerals, flavors, pigments) constituents; chemical, biochemical reactions and physical phenomena occuring during food handling, processing, and storage; their impact on the nutritional and sensorial quality of food. Pre: BCHM 2024. (3H,3C)

4524: FOOD SAFETY AND QUALITY ASSURANCE
Monitoring safety and quality of food as well as compliance with government regulations. Description of regulatory agencies and food regulations. Development of specifications, food standards and safety critical control points. Systems to assure a safe and quality product, including acceptance sampling and statistical process control. Pre: 3604, 4304. (3H,3C)

4534: FOOD CHEMISTRY LAB
Investigation of functional properties of proteins, carbohydrates, and lipids in processed foods including effect of environmental conditions; solubility, foaming ability and textural properties of proteins, carbohydrate crystallization, ability of polysaccharides to form gels and pastes, lipid absorption and tenderization, characterization of a natural-occurring enzyme. Co: 4504. (3L,1C)

4544: DISTILLATION AND FERMENTATION ANALYSIS
Sampling and analysis of pre-and post-fermentation foods and beverages to determine process termination, efficiency, and formation of desired and non-desired products. Laws and regulations pertaining to fermented foods and beverages. Distillation as an analytical tool and as a production method for food/beverage products. Pre: 4504, 3514. Co: 4104. (2H,3L,3C)

4634: EPIDEMIOLOGY FOODBORNE DISEASE
Overview of causes, transmission, and epidemiology of major environmental, food, and water borne diseases. Outbreak and sporadic detection, source tracking and control of pathogens. Overview of the impact of foodborne outbreaks on regulatory activities at the national and international level. Corequisite: Enrollment in either FST 3604 or BIOL 4674. Co: BIOL 4674, 3604. (3H,3C)

4644: FERMENTATION MICROBIOLOGY
Physiology, biochemistry, and genetics of microorganisms used for production of food ingredients, fermented foods, and beverages. How microorganisms are used in fermentation and the effects of processing and manufacturing conditions on production of fermented foods. Pre: BIOL 2604. (2H,2C)

4654: FOOD AND BEVERAGE FERMENTATION

Introduction to the broad range of fermented foods and beverages. Defining quality parameters of fermented foods and beverages. In-depth examination of the processing methods and equipment employed in commercial-scale production of fermented foods and beverages. Historical, cultural, sensory, and nutritional attributes of fermented foods and beverages. Course requirements may be satisfied by taking FST 3604 or FST 4504 prior to or concurrent with course. Pre: 4504 or 3604. Co: 4644. (1H,2L,2C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Geography

Head: T.W. Crawford
Professors: J.B. Campbell and L.W. Carstensen
Associate Professors: A. W. Ellis, L. M. Kennedy, K. N. Kolivras, and L.M. Resler
Assistant Professors: T. D. Baird, A. Bukvic, L. Juran, R. D. Oliver, Y. Shao, and S. Zick
Instructors: J. D. Boyer, D. F. Carroll, S. Scales, and K. Stiles
Career Advisors: M. Deisinger

Web: **www.geography.vt.edu**

Overview

Geography offers a unique perspective on many of today's most important issues--from globalization, international development, and culture change to environmental problems, population growth, and climate change. Its theories and methods provide analytical techniques applicable to a wide range of questions significant to a broad spectrum of occupations. The geography major provides a balance between an education focusing on contemporary social, political, economic, and environmental issues and training in advanced computer-based techniques.

Human geography is concerned with the spatial dimensions of human existence, the economy, politics, and culture as well as the relationshsips between humans and their environments.

Physical geographers study patterns of climate, landforms, vegetation, soils, water, and natural hazards

and particularly the processes that produce those patterns, including human-environment interactions.

Geospatial science involves Geographic Information Systems (GIS), Global Positioning Systems (GPS), web services, and remote sensing. These technologies have led to significant advances in the ways in which geographic information is collected, mapped, analyzed, and integrated in database and decision-making systems. All students are exposed to these technologies as they are integral to working in the field today regardless of specialization and topic of interest.

Training in geography provides valuable, marketable skills that are in high demand in business, government, and education. Geography majors obtain employment in such diverse fields as geographic information systems, satellite imagery analysis, planning, transportation, market analysis, health care analysis, cartography (map making), land and water management, recreation, and environmental conservation. Our students and graduates have worked with county, state, and federal agencies, privte firms, non-profit organizations, and international organizations. Employment opportunities are especially strong for students obtaining advanced training in geospatial computer techniques, which are used by both human and physical geographers.

Geography Major Degree Requirements

The department offers courses in human geography, physical geography, and geospatial information science. In addition to fulfilling the requirements of the General Education (Curriculum for Liberal Education), geography majors must also complete 48 hours in geography and related disciplines. All must take GEOG 1004, 1014, 1084, 1104, 2084, 2314, 3314, and one of STAT 2004, 3604, or 3615, and they must have a field experience of at least 3 credit hours from 2964, 2994, 3954, 4964, or 4994. Additionally, students must complete 18 credits of geography major courses and 3 credits from a cognate elective area. The Geography major leads to the B.A. in Geography degree.

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Checksheets with program requirements can be found on the Office of the University Registrar's website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Meteorology

Meteorology is a science that analyzes conditions in the atmosphere and the impacts of weather and climate on the surface of the Earth. Importantly, meteorologists use specialized training to predict and forecast weather conditions and the potential ways humans may be affected by weather and climate, and then communicate that information to decision-makers and the general public.

Our meteorology program integrates geospatial science and climate science into the meteorology core coursework, which allows our graduates to work in the exciting nexus between the atmosphere and the ground beneath it. Today's meteorologists access a wide range of careers in society ranging from forecasting and reporting for multi-media, aiding industry in assessing severe weather impacts on business infrastructure and supply chains, blogging and software development, research, and forecasting for military or federal careers. Our students and graduates have worked with the National Weather Service (Blacksburg office and others), National Severe Storms Laboratory, the Weather Channel, as on-air television meteorologists, as officers with military appointments, and with government and private agencies.eorology degree and provides full credentials to work for the federal government as certified meteorologist.

Degree Requirements

As part of fulfilling the requirements of the General Education (Curriculum for Liberal Education), meteorology majors must MATH 1225 and 1226 in additional to PHYS 2205/2215 and 2206/2216 or 2305 and 2306. Meteorology majors must also complete 72 hours in geography/meteorology and related disciplines. All must take GEOG 1004, 1014, 1084, 1104, 2084, either 2314 or 3314, 4084, 4354, 4554, one of STAT 2004, 3604, or 3615. Required meteorology courses are 1504, 1514, 2505, 2506, 3504, 3515, 3516, 4504, and 4524,. All students must also -complete MATH 1114 , and 2214. Furthermore, all students are required to complete a field experience of at least 3 credit hours from MTRG 2964, 3524, 3954, 4584, or 4994. The Meteorology major leads to the B.S. in Meteorology degree and provides full credentials to work for the federal government as certified meteorologist.

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

More information is available at **http://geography.vt.edu/programs/Meteorology.htm**.

Checksheets with program requirements can be found on the Office of the University Registrar's website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Minor Offered by the Department of Geography

Geography Minor Requirements

To graduate with a minor in meteorology, a student must complete 21 hours of geography/meteorology coursework, including GEOG 1104, 1514, 2505, 2506 and 3504; plus an additional 6 hours of geography classes, of which at least 3 hours must be at the 3000-4000 levels.

Geographic Information Science Minor Requirements

To graduate with a minor in Geospatial information Science, students in Geography or Meteorology majors must take an additional 12 hours of upper divisional classes in Geospatial Information Science from 4314, 4324, 4374, and 4394, CS 1064, FOR 4114 or FOR 4214.

Students in any major may take this minor by taking 18 hours of Geospatial Information Science coursework including 1084, 2084, 4084, and 4354; plus an additional 6 hours from 3314, 4314, 4324 4374, 4394, CS 1064, FOR 4114, or FOR 4214.

Sustainable Natural Environments Minor Requirements

To graduate with a minor in sustainable natural environments, a student must complete GEOG 1115, 1116, NR 4444 and 9 additional credits from a list of options. See minor checksheet for details.

Meteorology Minor Requirements>

To graduate with a minor in meteorology, a student must complete 21 hours of geography/meteorology coursework, including GEOG 1104, 1514, 2505, 2506 and 3504; plus an additional 6 hours of geography classes, of which at least 3 hours must be at the 3000-4000 levels.

Undergraduate Course Descriptions (GEOG)

1004: INTRODUCTION TO HUMAN GEOGRAPHY

Introduction to geography as a social science. Development of a conceptual framework for studying and evaluating human-environment relationships. Through examination of selected regional and global issues and through exploring basic concepts like regions, place, location, human-environment interaction, movement, and accessibility, students will discover how power is spatially expressed and explore how culture shapes the production of space and vice versa. Students will also discover and describe how ethical issues manifest spatially. (3H,3C)

1014: WORLD REGIONS
Human and physical patterns and characteristics of major regions of the world including political systems, religions, economies, and physical settings. Concepts and perspectives of geography as a social science; linkages and interdependence of nations and regions; analysis of media coverage of events or global issues; engagement with current and historical global affairs. (3H,3C)

1084 (FREC 1004): DIGITAL PLANET
Exploration of innovative geospatial technologies and their impact on the world around us, including how humans interact with the environment and each other. Roles of location-based services, global positioning systems, geographic information systems, remote sensing, virtual globes and web based mapping for environmental applications. Skills and techniques for spatial thinking and environmental decision-making. Ethical implications of the use of geospatial technologies, data, and computational approaches. (3H,3C)

1104: INTRODUCTION TO PHYSICAL GEOGRAPHY
Integrated study of major subsystems of the natural environment: the nature, distribution, and interrelationships of landforms, climate and vegetation. (3H,3C)

1115-1116 (NR 1115-1116): SEEKING SUSTAINABILITY
1115: Strategies to promote sustainability through the identification, description, and analysis of the dominant interconnections within and between environmental, social, and economic systems across local to global scales. 1116: Perceptions of, conditions of, and strategies to analyze processes of change within complex systems, and promote sustainability across local to global scales. (3H,3C)

1504: SURVEY OF METEOROLOGY
An introductory look into the world of meteorology, including the role of forecasters, broadcast meteorologists, current research, and the prediction and response to significant storm events. (1H,1C)

1514: INTRODUCTION TO METEOROLOGY
Introduction to the foundational properties and processes of Earth’s atmosphere and the consequential forms and patterns of weather, including atmospheric composition and structure, energy, humidity, clouds and precipitation processes, atmospheric motion, air masses, fronts, and cyclones, and severe weather and hurricanes. (3H,3C)

1524: INTRODUCTION TO EARTH’S CLIMATE
An introduction to Earth’s climate system, including the physical mechanisms responsible for the global climate as well as its spatial and temporal variation; composition and structure of the atmosphere, radiation budget and temperature, precipitation and hydrologic budget, atmosphere and oceanic circulation, weather systems, paleoclimate, future climate; synergistic human-climate relationships, including global warming, climate change. (3H,3C)

2004 (NR 2004) (WATR 2004): WATER, ENVIRONMENT, AND SOCIETY
Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on ethics and relationships between human needs for and effects upon water including: water quality, water treatment, and wastewater treatment; water for health, energy, and food; water management, laws, economics, and conflict; hydrometeorological hazards and climate change; and potential solutions for these and other critical water issues. (3H,3C)

2034 (IS 2034) (PSCI 2034): GEOGRAPHY OF GLOBAL CONFLICT
Geographical dimensions of global conflicts, international ’management’ of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the

geography of global conflict changes. (3H,3C)

2054 (IS 2054) (PSCI 2054): INTRODUCTION TO WORLD POLITICS
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues. (3H,3C)

2064 (IS 2064) (PSCI 2064): THE GLOBAL ECONOMY AND WORLD POLITICS
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies. (3H,3C)

2084: PRINCIPLES OF GEOGRAPHIC INFORMATION SYSTEMS
Principles and diverse applications of Geographic Information Systems, geographic coordinate systems, Cartesian map projections, spatial data sources, GIS databases, map representations, and illustrated spatial applications of GIS. Requires regular use of computer systems for geographic data analysis. (3H,3C)

2134 (IS 2134) (PSCI 2134): GEOGRAPHY OF THE GLOBAL ECONOMY
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century. (3H,3C)

2214: GEOGRAPHY OF NORTH AMERICA
Regional study of Anglo-American with consideration of relationships between natural environments and social, political, and economic developments. International issues involving Mexico also considered. (3H,3C)

2244 (SPIA 2244): SUSTAINABLE URBANIZATION
Process of urbanization and theories and approaches of urban development. Debates on the meanings of sustainable urbanization and development in cities and how they are measured. Urban sustainability initiatives in the context of urban political economies, land-use practices, urban inequality and diversity, urban nature, and urban policy and politics. Programs and policies designed to enhance sustainable urbanization. Comparative approach and global perspective. (3H,3C)

2314: MAPS AND MAPPING
Introduction to maps. Fundamentals of reading, analysis, and interpretation of hard copy and digital maps, as they are required to illuminate spatial problems. Influences of maps on attitudes toward and images of the geographic environment. (3H,3C)

2505,2506: WEATHER ANALYSIS I
Introduction to the operational tools and processes in weather forecasting. Surface data and upper-air sounding analysis, forces producing and directing wind flow, jetstreams, weather chart analysis, and atmospheric moisture including clouds and precipitation. (3H,3C)

2784: GEOGRAPHY OF TEA
Physical and human geographic overview of tea. Biogeography, history, economics, and ceremonial practices of the world’s tea producing regions. Analysis of terroir and processing through tasting exercises and sensory evaluation. Pre: Sophomore standing. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3034 (IS 3034) (PSCI 3034): THE CIA: ITS CAPABILITIES IN TODAY'S GEO-POLITICAL WORLD
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIA's operations in different regions of the world. (3H,3C)

3104: ENVIRONMENTAL PROBLEMS, POPULATION, AND DEVELOPMENT
Environmental problems in their social, spatial, and global contexts. Impacts of globalization, neoliberalism, and population growth on the environment. Examination of effects of developed and developing countries on the environment. Focus on conceptualizing development, population dynamics, environmental justice, factory farming, energy and renewable energy, global health, disasters, and intercultural and global awareness. (3H,3C)

3224: GEOGRAPHY OF APPALACHIA
Appalachia as a region: physical environment, development of internal settlement, cultural, and economic patterns. Human adaptations to environmental change, traditions, and connections to and from external regions. Pre: 1004 or 1104 or 1014 or APS 1704 or HUM 1704. (3H,3C)

3234: GEOGRAPHY OF VIRGINIA
Virginia as a region: its physical environment, settlement, cultural, economic, and political patterns. Human adaptation to environmental change, human modification of environments and linkages to external regions. Climate, Biogeography and Water, and Environmental Hazards related to Natural Resources. Pre: 3 credit hours of Geography. (3H,3C)

3244: THE U.S. CITY
The economic, political, and social forces driving urbanization in the United States. The American city in historical context with particular emphasis on the rise of manufacturing, deindustrialization, and suburbanization. Case studies from the manufacturing and sunbelt regions to illuminate key constructs from urban and human geography. "Border" examples of comparative urbanization from the U.S. - Mexican border, the Caribbean, and Canada. Junior standing required. (3H,3C)

3254: GEOGRAPHY OF EAST ASIA
A geographical analysis of several modern states in East Asia, specifically China, Japan and the Koreas. Economic, political, and cultural change since the end of World War II. Globalization and the emergence of the China as a demographic and economic giant. (3H,3C)

3274: GEORGRAPHY OF SUBARCTIC AND ARCTIC ENVIRONMENTS
Study of circumboreal arctic and subarctic environments from a holistic perspective, with emphasis on cultural, historical, geopolitical, and physical aspects of the North. Importance of arctic and subarctic regions in the global arena. Climate, geomorphology and community change. (3H,3C)

3304 (CSES 3304) (GEOS 3304): GEOMORPHOLOGY
Examines the variety of landforms that exist at the earth's surface. Detailed investigation of major processes operating at the earth's surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion. Pre: 1104 or GEOS 1004 or GEOS 2104. (3H,3C)

3314: CARTOGRAPHY
Science and art of cartography including the conceptual framework of the cartographic method. Development of the skills necessary to create maps to be used in the analysis of spatial phenomena. Emphasis on thematic and ethical cartography. (2H,3L,3C)

3404: MOUNTAIN GEOGRAPHY

Physical characteristics of mountains, such as steep slopes, climatic extremes, and sharp environmental gradients, and their influences on the ways in which people, animals, and plants interact. Physical processes that operate in high-relief environments, including consideration of climate, geomorphology and biogeography. Influence of physical processes in mountain environments on human culture and activities. Cultural significance of mountains. Mountains as a resource. Land use and human-land interactions in mountains. Course is intended for students with an interest in what makes mountains unique and inspiring landscape elements. Pre: 1104. (3H,3C)

3464 (AHRM 3464) (APS 3464) (HD 3464) (HUM 3464) (SOC 3464) (UAP 3464): APPALACHIAN COMMUNITIES
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

3504: SEVERE WEATHER
An introduction into mesoscale environments favoring the development of severe thunderstorms and tornadoes, the analysis of moisture, instability and shear parameters associated with severe weather events. Thunderstorm life-cycles, analysis of thermodynamic diagrams, role of wind shear and associated convective mode, hail production and forecasting, tornadogenesis and research. Pre: 2505. (3H,3C)

3515: DYNAMIC METEOROLOGY
Examination of the physics that govern motion of Earth’s atmosphere. General atmospheric concepts, atmospheric principles of thermodynamics, hydrostatics, and stability. 3516: Examination of the physics that govern motion of Earth’s atmosphere. Principles of fluid dynamics, specifically the physics governing horizontal motion, corresponding vertical motions, and synoptic scale systems, as represented in various coordinate systems. Pre: 2506, MATH 2214, (PHYS 2206, PHYS 2216 or PHYS 2306). (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4044 (BIOL 4044): BIOGEOGRAPHY
A survey of the field of biogeography. A study of the factors influencing the distribution of plants and animals approached from ecological, historical, and cultural perspectives. Human influence on biotic patterns, such as crop domestication, habitat alteration, species introductions and extinctions, management issues, and environmental change, is a primary focus. Pre: 1104 or BIOL 2804. (3H,3C)

4054: GEOGRAPHY OF WINE
Analysis of physical and cultural forces that shape the production, consumption, and great variety of wine in the world. Wine as a complex commodity is examined through its economic, social, political, and ideological impacts in different parts of the world throughout history. Particular emphasis will be focused on place as an agent in defining the product. (3H,3C)

4074: MEDICAL GEOGRAPHY
Geographic patterns of disease and health care at various scales. Study of interactions between the physical environment and health. Analysis of spatial patterns associated with HIV/AIDS epidemic. Examination of health implications of social and cultural variation in developed and developing contexts. Pre: Junior standing. (3H,3C)

4084 (GEOS 4084): MODELING WITH GEOGRAPHIC INFORMATION SYSTEMS
Use of automated systems for geographic data collection, digitization, storage, display, modeling and analysis. Basic data flow in GIS modeling applications. Development of proficiency in the use of current GIS software. Senior Standing. Pre: 2084. (1H,6L,3C)

4134 (GEOS 4134): INTERDISCIPLINARY ISSUES AND ETHICS IN WATER RESOURCES
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Junior standing. (3H,3C)

4204: GEOGRAPHY OF RESOURCES
Physical and cultural systems that influence the spatial distribution of resources and resource use. Emphasis on historical and current contexts of natural resources use and perspectives in the United States, with consideration of worldwide distributions of resources. Environmental cognition and perception, water, public lands, conservation and preservation, food and hunger, human population, and alternative energy. Junior Standing. (3H,3C)

4214 (UAP 4214) (WGS 4214): GENDER, ENVIRONMENT, AND INTERNATIONAL DEVELOPMENT
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing. (3H,3C)

4224: TRACKING ENVIRONMENTAL CHANGE
Multidisciplinary approaches to documenting and understanding past environmental change. Methods used to unravel the physical and human drivers of historical and longer-term changes in climate, vegetation, and fire patterns. Application of environmental change data and insights to improve land and conservation management under changing climates. Pre: Junior standing (3H,3C)

4314: SPATIAL ANALYSIS IN GEOGRAPHIC INFORMATION SYSTEMS
Theory and application of Geographic Information Systems, with special emphasis on analytical operations, database design, cartographic modeling, and raster GIS. Spatial data handling and analysis to facilitate decision-making through the communication of geographically referenced data. Pre: 4084. (2H,3L,3C)

4324: ALGOTRITHMS IN GEOGRAPHIC INFORMATION SYSTEMS
Computational methods in automated mapping and map analysis. Visual Basic programming and algorithm design for spatial display and analysis under both raster and vector data models. Requires regular use of the departmental microcomputer and UNIX workstation laboratory. Variable credit course. Pre: 4084, CS 1044.

4334: GEOSPATIAL INFORMATION TECHNOLOGY FOR LAND CHANGE MODELING
Analysis of the spatio-temporal patterns of Land Use and Land Cover Change (LULCC) as observed in satellite images. Tropical deforestation, urbanization, and agricultural intensification. Rates and patterns of LULCC linked to biophysical and socio-economic drivers. Impacts of land change with respect to local climate, biodiversity, water yield and quality, and ecosystem services. Pre: 4084. (3H,3C)

4354 (GEOS 4354): INTRODUCTION TO REMOTE SENSING
Theory and methods of remote sensing. Practical exercises in interpretation of aerial photography, satellite, radar, and thermal infrared imagery. Digital analysis, image classification, and evaluation. Applications in earth sciences, hydrology, plant sciences, and land use studies. (2H,3L,3C)

4374: REMOTE SENSING AND PHENOLOGY
Analysis of spatial and temporal patterns of the vegetated land surface as observed by satellite images. Application of satellite image time series to derivation of land surface phenology, and analysis of the appearance and development of phenology in the USA and worldwide. Methods of monitoring of phenology with satellite imagery. Causes of spatio-temporal changes of phenological events. Effects of global climate change. Pre: 4354. (3H,3C)

4394: INTRODUCTION TO WEB MAPPING
Application of web mapping technologies to geographic data collection, storage, analysis, and display. History and context, spatial data infrastructures, hardware and software architectures, open geospatial consortium standards, mapping APIs, virtual globes, user-centric design, web cartography. Group and individual projects. Pre: 4324. (3H,3C)

4444 (NR 4444): PRACTICING SUSTAINABILITY
Practicum in sustainability. Synthesize and integrate knowledge from undergraduate career and apply to

real world problems of sustainability. Topics and projects selected from opportunities to examine specific local and regional sustainability issues on the VT campus, in the New River Valley and the Commonwealth at large. Pre: Senior Standing. (3H,3C)

4504: SYNOPTIC METEOROLOGY
Examination of large-scale (1000-5000km) weather systems using both analytical and operational analysis. Topics include thermal structure of atmosphere & resulting circulation, frontal analysis, lifting mechanisms, barotropic/baroclinic systems, and mid-latitude cyclones. Weather pattern influences of the jetstreams and oscillation of large pressure systems including El Nino/La Nina and the North Atlantic Oscillation. Pre: 3504, MATH 1226. (3H,3C)

4514: TROPICAL METEOROLOGY
Tropical weather and climate topics: remote sensing and observations; tropical climatology, including regional and large-scale circulations, monsoons, and the El Nino/Southern Oscillation; tropical convection, including the clouds in the subtropics, deep convection in the equatorial region, and tropical cloud clusters and thunderstorms; and tropical cyclones, including their structure, intensity, lifecycle, and formation. Pre: 2506, 3504. (3H,3C)

4524: PHYSICAL METEOROLOGY
Study of the physics associated with cloud and precipitation development, the emission, absorption, and transmission of solar and terrestrial radiation, meteorological acoustics, and atmospheric electricity. Pre: 3515. (3H,3C)

4554: REMOTE SENSING OF ATMOSPHERE
Remote sensing technologies used in monitoring weather. Evaluation of Doppler radar products, including base reflectivity, base velocity, storm-relative velocity, and vertically integrated liquid imagery. Could observation through infrared and visible satellite imagery; remote weather station design, set-up and data retrieval. Pre: 4354. (1H,1C)

4764 (SOC 4764) (UAP 4764): INTERNATIONAL DEVELOPMENT POLICY AND PLANNING
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (MTRG)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

3524: METEOROLOGY FIELD METHODS
A field methods course in meteorology. On-location observation and analysis of temperature, wind fields, pressure, and dewpoint. In-field experiences with radar and satellite data, numerical model output and portable weather stations. On-location sites and corresponding curriculum may include severe storm

analysis in the Great Plains, mountain weather in the White Mountains (NH) or Rocky Mountains (CO), and costal storms along the Atlantic or Gulf of Mexico coastlines. May be repeated for credit, with permission and different content, for a maximum of 9 hours. Pre: GEOG 2506, GEOG 3504. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4584: TOPICS IN APPLIED METEOROLOGY
Contemporary and emerging theory and praxis in meteorology. Variable topics such as operational weather forecasting situations and scenarios. Identifying common meterological problems and developing pragmatic approaches for solutions. Repeatable with different content for a maximum of six credit hours. Variable credit course. Pre: GEOG 1514.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Geosciences

Head: W.S. Holbrook
University Distinguished Professors: R.J. Bodnar, P.M. Dove, G.V. Gibbs (Emeritus), and M.F. Hochella Jr. (Emeritus)
National Academy of Science: P.M. Dove
Professors: R.J. Bodnar, T. J. Burbey, P.M. Dove, K.A. Eriksson, W.S. Holbrook, J.A. Hole, S.D. King, R.D. Law, N.L. Ross, M.E. Schreiber, J.A. Spotila, and S. Xiao
Associate Professors: M.J. Caddick, B.C. Gill, B.W. Romans, R. Weiss and Y. Zhou
Assistant Professors: M. Duncan, C. Dura, F.M. Michel, S.J.Nesbitt, R.M. Pollyea, D.S. Stamps, and M.R. Stocker
Research Professor: M.C. Chapman and R.P. Lowell
Collegiate Associate Professor: J.A. Chermak
Senior Research Associate: L. Fedele
Advanced Instructor: N.E. Johnson
Adjunct Faculty: J. Beard, I. Cozzarelli, B. DeVivo, W. Henika, and P. Prince
Affiliated Faculty: M. Murayama

Web: **www.geos.vt.edu**
E-mail: **geosciences@vt.edu**

Overview

Geosciences offer exciting opportunities for students with an interest in applying a full range of science and mathematical skills to understand the earth's properties and dynamic processes. This is a highly interdisciplinary program that applies physics, chemistry, biology, and mathematics to understand and manage all aspects of Earth and the environment. Geoscientists work everywhere in the world under almost any condition as they search for earth resources, manage the environment and natural hazards, and supervise technical and business enterprises. For more information about exciting careers in Geosciences consult **www.agiweb.org/careers.html**. The extensive scientific and mathematical skills of geoscientists, along with their broad field experience, allow them to pursue careers in many related fields ranging from material science to technical management to scientific reporting.

The internationally recognized faculty in Geosciences has developed four challenging options, described below, that lead to a B.S. in Geosciences. Coursework emphasizes the acquisition and processing of field data beginning with a special course in field methods taken in the spring of the first year. The geology option requires, and the other options recommend, that the student participate in a six-week field camp. The B.S. in Geosciences provides pre-professional preparation that will allow students to continue their education in post graduate programs in science, law, and business.

Earth systems and processes are enormously complicated and require a full range of intellectual skills to decipher and manage. Geoscientists must possess strong quantitative skills and a solid understanding of physics, chemistry, and biology. They must be able to read maps, identify rocks, minerals, and fossils as well as visualize earth structures in three dimensions. They must have strong communication skills, both written and verbal. Learning to use these skills in an integrated way is a challenging and rewarding experience.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Geology Option

The Geology option offers a detailed coverage of the broad range of classic disciplines within the geosciences. This option emphasizes the study of minerals, rocks and fossils, and teaches the student how to understand the processes and history of the earth based on the occurrences and relationships of these materials at or near the Earth's surface.

Geochemistry Option

The Geochemistry option is designed for those students who have special interest in the chemical aspects of the Earth and its materials.

Geophysics Option

The Geophysics option offers the student the opportunity to specialize in the branch of the geosciences that investigates physical earth processes such as earthquakes and that images the interior of the earth through surface-based physical measurements.

Earth Science Education Option

The Earth Science education option provides students with a broad earth science curriculum that meets the content goals for secondary earth science teaching. Certification for Earth science teaching is not provided in the program. Information about teaching certification in Virginia can be obtained from the Department of Teaching and Learning.

Minor in Geosciences

The requirements to earn a minor in Geosciences can be found on its checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Graduate Program

The department offers M.S. and Ph.D. degrees in geosciences with specializations in many sub-disciplines. (See the **Graduate Catalog** for further information.)

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Geosciences with any of the available options can be found on the specific major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (GEOS)

1004: EARTH SCIENCE: OUR PAST, PRESENT, AND FUTURE
Introduction to Earth science, including the fundamental concepts of geology in the modern context of humans interacting with the Earth. Formation and evolution of the Earth (history, plate tectonics, the rock cycle, geologic time), internal Earth dynamics (earthquakes, volcanoes, mitigating natural hazards), Earth materials (minerals and rocks, energy and mineral resources), surface processes (Earth system science, hydrologic cycle, global geochemical cycles, oceans and atmosphere, climate, erosion and landscapes), Earth sustainability (resources, environmental change), evaluating geological information and products of research, the scientific approach to problem solving, and the ethical issues associated with geoscience and the environment. (3H,3C)

1014: EVOLUTION OF THE EARTH-LIFE SYSTEM
Introduction to the interaction of the Earth's processes that shape our planet and its biosphere through time. Application of modern geoscientific inquiry; biological, chemical and physical interactions that are part of the Earth system; distribution of life on Earth (i.e., biogeography); diversity of life over time; the differentiation between science and pseudoscience; ethical issues around human activities and their impact on the Earth-Life system. (3H,3C)

1024: EARTH RESOURCES, SOCIETY, AND ENVIRONMENT
Introduction to the Earth's resources including their nature, formation, occurrence, extraction, distribution, consumption, and waste management and disposal using an integrated cradle to grave analysis. Population, the Earth's metallic and non-metallic resources, rare earth elements, non-renewable and renewable energy and water. Social, environmental, economic and political impacts resource production

and consumption have had historically, currently, and that are predicted into the future including current and future sources of energy in the United States and internationally. Sustainability, water abundance and quality, fracking, climate change, ocean acidification, and ozone depletion. (3H,3C)

1034: EARTH'S NATURAL HAZARDS
Fundamentals of Earth processes that drive natural hazards, including earthquakes, volcanoes, tsunamis, hurricanes, tornadoes, floods, climate change and impacts with space objects; impacts of human activities on the Earth; defining and analyzing hazards and risks through testing hypotheses on geologic data; ethical issues arising from hazard mitigation; analysis of uncertainties of scientific information. (3H,3C)

1054: AGE OF DINOSAURS
Introduction to dinosaur paleontology, including fundamental geological and biological concepts, with focus on how modern paleontologists ask interdisciplinary questions to examine the fossil record. Use of dinosaurs to explore: process and impact of scientific method; geologic processes, geologic time, global change, ecosystems, biogeography; anatomy, evolution, biodiversity, phylogenetic relationships; and media portrayal of extinct animals. (3H,3C)

1104: INTRODUCTION TO EARTH SCIENCES LABORATORY
Introduction to Earth sciences laboratory, including identification of minerals and rocks, topographic and geologic maps, structural geology, geology impacting humans and humans impacting geology, environmental and social impacts. (3L,1C)

1124: EARTH RESOURCES, SOCIETY & ENVIRONMENT LABORATORY
Laboratory course on Earth's resources including their nature, importance, occurrence, extraction, and environmental, social, and political impacts of consumption. Earth's resources include metal ores, non-metallic resources which includes surface and ground water and non-renewable (e.g., fossil fuels) and renewable energy (e.g., hydroelectric). Sustainability, water quality and quantity, climate change, and ocean acidification related to resource extraction and consumption. (3L,1C)

2004: GEOSCIENCE FUNDAMENTALS
Introduction to geoscientific reasoning, methods, written and oral communication, professional expectations, and career options. Scientific methodology, empirical reasoning, and the specific application of these methods to conducting investigations and communicating the results to a geoscientific audience. Introduction to: accessing and using the geoscientific literature, conducting research, collaborating in research groups, using technologies that support collaborative oral and written communication, and building a professional presence. Restricted to Geoscience majors. (2H,3L,3C)

2014: MISSION TO THE PLANETS
The events and processes that shaped the terrestrial planets; the scientific method (i.e., observations, techniques, and theories) that supports our understanding of these events and processes; the role of science, politics, and engineering and how these impact planetary science missions; ethical issues associated with planetary research; manned and unmanned exploration and how they have shaped our understanding of the planets. (3H,3C)

2024: EARTH'S DYNAMIC SYSTEMS
Overview of the geosciences emphasizing processes operating within and on Earth now and over the last 4.55 billion years Integrates Earth's systems and cycles, includes the rock cycle, hydrologic cycle, origin and evolution of life, extinction. Earth's surface, and atmosphere. Field trips required. Restricted to geosciences majors. Partial duplication of GEOS 1004. (6H,6L,8C)

2104: ELEMENTS OF GEOLOGY
Structure of the earth, properties of minerals and rocks, and geologic processes that act on the surface and in the interior of the earth, and integrated geologic systems of importance in engineering and regional planning. For students in engineering and physical sciences. Geology 2104 duplicates material in Geology 1004 and both may not be taken for credit. (2H,3L,3C)

2444: GEOSCIENCE FIELD OBSERVATIONS

Study of geological phenomena in the field. Students make observations in the field, integrate them into coherent datasets, and construct interpretations. Rock type and structure identification in outcrop. Field techniques and applications in structural geology, sedimentology, stratigraphy, geomorphology, environmental geology, hydrogeology, geochemistry, and geophysics. 10 full days spent in the field (Mondays through Fridays during Summer I), plus additional classroom or laboratory meetings. Pre: (1004, 1104) or 2024 or 2104. (6L,2C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course. X-grade allowed.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course. X-grade allowed.

3014: ENVIRONMENTAL GEOSCIENCES
The roles of geology and geophysics in defining and monitoring the natural environment, with special application to interactions between humans and the geologic environment. Both descriptive treatment and quantitative concepts related to environmental processes involving the solid earth and earth's surface, with emphasis on geologic hazards (e.g., earthquakes, volcanoes, landslides and slope failures, flooding, groundwater problems, mineral and rock dusts). Pre: 1004 or 1024 or 2024 or 2104. (3H,3C)

3024: FORTRAN FOR PHYSICAL SCIENCE
Computer programming using Fortran 95 with applications to physical science, including statistics, physics, geology, and hydrology. Applications used to expose students to the capabilities of the language will include arrays, I/O concepts, structured programming, data types, procedures and modules, and dynamic data structures. Pre: (MATH 1114 or MATH 2114 or MATH 2114H), (MATH 1206 or MATH 1226) or (MATH 2015 or MATH 1026). (3H,3C)

3034: OCEANOGRAPHY
Descriptive and quantitative treatment of the geological, physical, chemical and biological processes that occur in, or are influenced by, the oceans. The history of oceanic exploration and discovery is addressed. (3H,3C)

3104: ELEMENTARY GEOPHYSICS
Acquisition and interpretation of exploration geophysical data. Seismic reflection and refraction methods, gravity and magnetic fields, geoelectrical methods, and geophysical well logging. Pre: 1004 or 2024 or 2104, MATH 1226, PHYS 2305. Co: PHYS 2306. (2H,3L,3C)

3204: SEDIMENTOLOGY-STRATIGRAPHY
Study of sedimentary basins in a plate-tectonic framework, mechanisms of basin formation, three-dimensional geometry of basin fill, and controls on basin fill. Siliciclastic and carbonate-evaporate rocks as examples of basin fill are discussed in lectures and studied in the lab and in the field. Applied aspects of the course include a discussion of geometries of sedimentary aquifers and reservoirs. Pre: 1004 or 2024 or 2104. (2H,3L,3C)

3304 (CSES 3304) (GEOG 3304): GEOMORPHOLOGY
Examines the variety of landforms that exist at the earth's surface. Detailed investigation of major processes operating at the earth's surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion. Pre: GEOG 1104 or GEOS 1004 or GEOS 2104 or GEOS 2024. (3H,3C)

3404: ELEMENTS OF STRUCTURAL GEOLOGY
Introduction to basic geological structures, evolution of microfabrics, development of faults, folds and foliations, stereographic analysis of geological structures, thrust fault geometries, balancing of geological

cross-sections, and introduction to the concepts of stress and strain. Pre: 1004 or 2024 or 2104. (2H,3L,3C)

3504 (MSE 3104): MINERALOGY
Principles of modern mineralogy, crystal chemistry, and crystallography, with emphasis on mineral atomic structure and physical property relationships, mineralogy in the context of geology, geochemistry, environmental science and geophysics, phase equilibria, mineral associations, and mineral identification, and industrial applications of minerals. There are three required field trips during the semester. Pre: CHEM 1035. (2H,3L,3C)

3604: PALEONTOLOGY
Paleontological principles and techniques and their application to the evolution of life, the ecological structure of ancient biological communities, the interpretation of ancient depositional environments, and the history of the earth. Pre: (1004, 1014) or 2024. (2H,3L,3C)

3614 (CSES 3114) (ENSC 3114): SOILS
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant- and earth-science majors. Partially duplicates CSES/ENSC 3134. Pre: CHEM 1036. (3H,3C)

3624 (CSES 3124) (ENSC 3124): SOILS LABORATORY
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates CSES/ENSC 3134. Co: 3614. (3L,1C)

3704: IGNEOUS AND METAMORPHIC ROCKS
Study of characteristics and mechanisms of igneous intrusion at depth in the crust, volcanic phenomena on the surface, and textural and mineralogical modification of rocks at elevated temperatures and pressures of crustal metamorphism. Tectonic aspects of igneous and metamorphic rocks will be stressed. Pre: (1004, 1104) or 2024. (2H,3L,3C)

3954: STUDY ABROAD
Variable credit course.

4024: SENIOR SEMINAR
Investigation and solution of significant geologic research problems by analysis and integration of information across a wide spectrum of Geosciences subdisciplines, and the presentation of results in oral and written form. Research projects will provide maximum student exposure to the full breadth of the Geosciences and the interrelated nature of subdisciplines. Pre: 3204, 3404. Co: 3104, 3704, 3604. (3H,3C)

4084 (GEOG 4084): MODELING WITH GEOGRAPHIC INFORMATION SYSTEMS
Use of automated systems for geographic data collection, digitization, storage, display, modeling and analysis. Basic data flow in GIS modeling applications. Development of proficiency in the use of current GIS software. Senior Standing. Pre: 2084. (1H,6L,3C)

4124: SEISMIC STRATIGRAPHY
Overview of seismic data acquisition and processing methods, seismic wavelets, static and dynamic corrections, and seismic velocities; seismic reflection data interpretation; seismic reflection responses Seismic mapping; seismic stratigraphy and seismic lithology. Consent required. Pre: 3104, 3204. (2H,3L,3C)

4134 (GEOG 4134): INTERDISCIPLINARY ISSUES AND ETHICS IN WATER RESOURCES
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Junior standing. (3H,3C)

4154: EARTHQUAKE SEISMOLOGY
Seismicity and its causes in the context of plate tectonics; determination of earthquake location, size and focal parameters; seismogram interpretation; seismometry; hazard potential; use of earthquakes in determining earth structure. Pre: MATH 2204 or MATH 2204H, MATH 2214, PHYS 2305, GEOS 3104. (2H,3L,3C)

4164: POTENTIAL FIELD METHODS IN EXPLORATION GEOPHYSICS
Theory and application to engineering, environmental, and resource exploration. Gravity, magnetics, electrical resistivity, self potential, induced polarization, ground-penetrating radar, magnetotellurics, electromagnetic induction. Pre: MATH 2204 or MATH 2204H, MATH 2214, PHYS 2306, GEOS 3104. (3H,3L,4C)

4174: EXPLORATION SEISMOLOGY
Theory and application of seismic methods to engineering, environmental and resource exploration: reflection seismics, refraction seismics, and tomography. Data acquisition, digital filtering, data corrections, imaging, interpretation, and forward modeling. Pre: MATH 2204 or MATH 2204H, MATH 2214, PHYS 2305, GEOS 3104. (3H,3L,4C)

4234: VERTEBRATE EVOLUTION
Characterization of the evolution of vertebrates from the fossil record to now. Tracing anatomical features in humans to their origin of different vertebrate groups. Chronicling vertebrate diversification events through extinctions, changes in climate in the last 600 million years, biogeography, and phylogenetic methods. Evidence of evolution through fossils and dissection. Pre: 1014 or BIOL 2704 or GEOS 2024. (3H,3L,4C)

4354 (GEOG 4354): INTRODUCTION TO REMOTE SENSING
Theory and methods of remote sensing. Practical exercises in interpretation of aerial photography, satellite, radar and thermal infrared imagery. Digital analysis, image classification and evaluation. Applications in earth sciences, hydrology, plant sciences, and land use studies. (2H,3L,3C)

4404: ADVANCED STRUCTURAL GEOLOGY
Basic principles of rock behavior under applied, non-hydrostatic stress (experimental and tectonic) and analysis of the geometrical patterns produced. Alternate years. Pre: 3404. (2H,3L,3C)

4624: MINERAL DEPOSITS
Introduction to the range and variety of metallic and non-metallic economic mineral deposits. Classification of the petrologic and tectonic settings of mineral deposits. Source, transport and depositional mechanisms of mineral deposit formation. Laboratory emphasizes identification of ore minerals, gangue minerals, common host rocks, wall-rock alteration and mineral zoning. Course requirement of 3 hours of GEOS at the 3000-level or above, may be satisfied by taking prerequisite prior to or concurrent with course. Pre: 1004 or 2104 or 2024. (2H,3L,3C)

4634: ENVIRONMENTAL GEOCHEMISTRY
Application of quantitative methods of thermodynamic and physicochemical analysis to the study of the distribution and movement of chemical elements in surface and near-surface geological environments. Emphasis on practical approaches to environmental geochemistry. Pre: MATH 1225, CHEM 1035. (2H,3L,3C)

4714: VOLCANOES AND VOLCANIC PROCESSES
Study of characteristics and mechanisms of volcanic phenomena, including magma dynamics, origin and chemistry of lavas, physics of eruptions, and characteristics of volcanic products, particularly pyroclastic deposits. Includes focus on volcanism as a general planetary process, on terrestrial tectonic settings of volcanism and on volcanic hazards. (2H,3L,3C)

4804: GROUNDWATER HYDROLOGY
Physical principles of groundwater flow, including application of analytical solutions to real-world problems. Well hydraulics. Geologic controls on groundwater flow. Pre: (MATH 1226 or MATH 2024), (PHYS 2205 or PHYS 2305). (2H,3L,3C)

4924: TECTONICS
Overview of modern plate tectonic theory and history. Physical processes driving present-day plate tectonic deformation including continental rifts, rifted margins, continental transforms, strike-slip faults, subduction zones and orogenic belts. Plate kinematic concepts and information about the Earth\031s structure. Application of scientific method, data analysis, and computational modeling. Pre: (MATH 1025 or MATH 1225), (PHYS 2205 or PHYS 2305). Co: 3104. (3H,3L,4C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
May be repeated for a maximum of 4 credits. Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Human Development and Family Science

Head: April Few-Demo
Alumni Distinguished Professor: R. Blieszner
Professors: K. R. Allen, J. Arditti, M. Boucouvalas, E. McCollum, F. P. Piercy, K. A. Roberto, and L. Sands
Associate Professors: M. L. Dolbin-MacNab, M. Falconier, A. L. Few-Demo, C. Kaestle, K.J. Kim, T. Savla, and C. L. Smith
Assistant Professors: J. Case Pease, K. Choi, E. Grafsky, C. B. Hornburg, J. Jackson, B. Katz, A. Landers, J.M. Russon, C. Shivers, and R. Wesche
Research Scientist: I. Bradburn
Senior Instructor: M.E. Verdu
Advanced Instructor: K. Gallagher and I. Schepisi
Instructor: V. Lael, M. Komelski, and I. Schepisi

Web: **www.hdfs.vt.edu**

Overview

The Department of Human Development offers an undergraduate degree in Human Development, focusing on family relationships and of human development across the lifespan, and public policies and issues that impact individuals and families. It offers a second degree in early childhood education. The department's mission is to understand and improve the lives of people of all ages in relationships, families, organizations, and communities.

The program participates in the University Honors Program.

The department offers graduate programs leading to the M.S. in applied human development at the Blacksburg campus, as well as marriage and family therapy at the National Capital Region campus. The department also offers graduate programs leading to the Ph.D. in adult development and aging, adult learning and human resource development, child and adolescent development, family studies, and marriage and family therapy. Graduate students can earn the Graduate Certificate in Gerontology along with their degree or as Commonwealth Campus students (for more information, contact the Center for Gerontology, 237 Wallace Hall, (540) 231-7657). (See **Graduate Catalog**)

Human Services

Career Advisors: M. E. Verdu

The degree in human development is for students interested in a wide variety of careers and graduate school programs. The option provides undergraduate majors with a theoretical and experiential grounding in child and adult development and in family and relational dynamics. Course work includes emphases on how individuals and families develop over the life cycle, on the critical issues and events that influence families, and on family transitions and dynamics. The curriculum also focuses on human sexuality, family diversity, and social and public policies that affect individuals and their families. Through course work and field placement experiences, human services students develop and practice skills and communication techniques for working with individuals, families and groups. In addition to course work with the Department of Human Development, human services students take courses in the areas of psychology, sociology, biology, statistics and mathematics, writing and communication, family economics, creative arts, cultural traditions, and international perspectives on human concerns. Students may tailor their studies to their particular professional goals and interests through the use of free electives.

The field study, which integrates theory, research and practice, is a pivotal experience in students' career development. It increases students' communication and practice skills and helps narrow career interests. Careers open to human services graduates include: preschool, elementary, family & consumer science and special education, employment and job training services, health and wellness programs, housing services, income programs, mental health services, nutrition and meals programs, protective services, recreation programs, respite services, social services, substance abuse programs, volunteer programs, and child care services. Graduate and professional options that human services graduates may consider include business, community health and public health, law, education, family studies, gerontology, marriage and family therapy, medicine and nursing, psychology and sociology, public administration, rehabilitation, and social work.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Free Electives (Select 33-35 credits)

Students are encouraged to consider the wide array of courses across the university curriculum as potential choices for electives to support their Human Services major. In consultation with the major advisor, each student should confirm that prerequisite requirements have been met before enrolling in elective courses.

Satisfactory Progress

A student will be considered to have made satisfactory progress toward the degree when he/she has successfully completed the Curriculum for Liberal Education requirements for English, mathematics, and biology, and HD 1004, by the time the student has attempted 72 semester credits.

Undergraduate Course Descriptions (HD)

1004: HUMAN DEVELOPMENT I: CHILDHOOD AND ADOLESCENCE
Basic concepts related to normal human development. Emphasis on developmental theories and principles of physical, social, and emotional growth, development, and behavior of children, individually and within families and cultures, from conception through adolesence. Designed as a general survey course for majors and non-majors. (3H,3C)

1134: INTRO TO DISABILITIES STUDIES
Introduction to concepts realted to physical, intellectual, cognitive, and emotional disability, with a focus on disability as a social construct and lived experiences of people with disabilities across the lifespan. Exploration of texts, videos, and other created artifacts to evaluate concepts and models of disability. (3H,3C)

1984: SPECIAL STUDY
Variable credit course.

2004: HUMAN DEVELOPMENT II: ADULTHOOD AND AGING

Introduction to adult development and aging (gerontology). Basic concepts, principles, theories, research methods and social issues of development from emerging adulthood through the end of life. Biopsychosocial analysis of issues affecting aging processes. Includes multicultural and global perspectives and challenges in aging. Pre: 1004. (3H,3C)

2014: INTEGRATIVE PRACTICES FOR HEALTH, WELLBEING, AND RESILIENCE
Theories of integrative (mind-body) health and wellbeing. Examination of multidimensional factors, including stress, personality, relationships, and social environment, as well as issues of identity and equity that influence health across the lifespan. Engagement in contemplative and evidence-based integrative health practices used for promoting health, wellbeing, and resilience. Attention given to ethical use and teaching of practice methods. (3H,3C)

2104 (SOC 2104): QUANTITATIVE APPROACHES TO COMMUNITY RESEARCH
Computational methods and ethical issues in the collection, transformation, consumption, and use of quantitative data in the design and evaluation of community programs. Consideration of effective data visualization and communication of findings. Emphasis on evaluating the reliability and accuracy of data used to frame decisions about community-related policies and service-oriented programs. (3H,3C)

2304: FAMILY RELATIONSHIPS
Overview of basic concepts, principles, theories, and issues of development and change in family relationships. Topics include families in historical and contextual perspective, structural and relational diversity in families, and processes of relational development, maintenance, and dissolution in families. (3H,3C)

2314: HUMAN SEXUALITY
Explores the diversity of human sexuality using global perspectives. Biological, historical, developmental, psychological, sociological and self-reflexive approaches. Interdisciplinary examination of the social constructions of sexuality and gender; the historical and contemporary theoretical perspectives and research on sex; the interactions of race, ethnicity, class, gender, sexual orientation, religion, ability, and nationality in shaping sexuality and family formation; the international commercialization of sex; the impact of violence and sexual coercion; the debates surrounding sexual ethics, unintended pregnancy, sex education, and biotechnology; the application of the scientific method, study designs, and methods of observation; the promotion of sexual and reproductive health across the lifespan; and the development of sexual practices, rituals, mythologies, belief systems and other cultural contexts for sexuality across time and around the world. (3H,3C)

2335-2336: PRINCIPLES OF HUMAN SERVICES
2335: Basic concepts, techniques, and structure of the human services profession. Survey of client/family assessment and problem management. 2336: Advanced topics in human services focusing on: case management, crisis intervention, program administration, specialized interventions, ethics, and professional development. Pre: 1004 for 2335; 2335 for 2336. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course. X-grade allowed.

3014: RESEARCH METHODS IN HUMAN DEVELOPMENT
Critical thinking and problem-solving involved in applying methods of scientific inquiry to the field of human development. Topics include methods of data collection, basic methods for displaying and analyzing data, and writing reports. Pre: 2004, 2304, STAT 3604. (2H,1L,3C)

3024: COMMUNITY ANALYTICS
Application of data analytics concepts to community issues at local and global levels. Data sources, data quality, data representation and data ethics. Statistical analysis to improve community livability. Communication of data and statistics for community stakeholders. Evaluation of reports that use data. Sophomore standing or higher. (3H,3C)

3114: ISSUES IN AGING
Seminar which investigates selected contemporary issues in adulthood and old age, such as family and friend relationships; work and retirement; political, legal, and economic issues; and women's concerns. (3H,3C)

3144 (EDCI 3144): EDUCATION OF EXCEPTIONAL LEARNERS
Introduction to the historical, ethical, legal, and economic models relevant to understanding students with disabilities and meeting their needs to increase their potential for success throughout their lives. Addresses research in early intervention, K-12 instruction, post-secondary education, and transition into work settings. (3H,3C)

3214: INFANCY AND EARLY CHILDHOOD
Theories, principles, normal patterns of physical, cognitive, social, and emotional development from conception to the early school years. Micro and macro environmental influences on development are considered as they interact with genetic/biological determinants of development. Pre: 1004. (3H,3C)

3224: MIDDLE CHILDHOOD AND ADOLESCENCE
Theories, principles, normal patterns of physical, cognitive, social, and emotional development from middle childhood to adolescence. Micro and macro environmental influences on development are considered as they interact with genetic/ biological determinants of development. Pre: 1004. (3H,3C)

3234: LIFESPAN COMMUNITY SERVICES
Health and human service programs serving children, youth, older, adults, and families. Overview of community programs for individuals and families over the lifespan; methods of determining service eligibility; procedures for maintaining quality assurance. Pre: 1004, 2304, 2004. (3H,3C)

3254: CURRICULUM IN EARLY CHILDHOOD
Supervised experience in planning and implementing emergent, play-based learning experiences for young children; examination of the role of the teacher; exploration of early childhood curricular design and materials suitable for addressing milestones of child development based on theory and research. Pre: 1004, 3214. (3H,3C)

3304: ADVANCED HELPING SKILLS
Helping skills used in human services settings. Case management, evaluating crisis situations, and approaches to individual and family assessment. Pre: 2335, 2336. (3H,3C)

3464 (AHRM 3464) (APS 3464) (GEOG 3464) (HUM 3464) (SOC 3464) (UAP 3464): APPALACHIAN COMMUNITIES
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4304: HUMAN SERVICES ADMINISTRATION
Issues, functions, and responsibilities involved in developing, implementing, and evaluating family and human services programs. Pre: 3234 or 3114. (3H,3C)

4324: ADVANCED FAMILY RELATIONSHIPS

Investigation of challenges, stresses, and crises experienced by individuals and families; protective factors and resilience; coping strategies; prevention and intervention; public policies. Pre: 2304. (3H,3C)

4324H: ADVANCED FAMILY RELATIONSHIPS
Investigation of challenges, stresses, and crises experienced by individuals and families; protective factors and resilience; coping strategies; prevention and intervention; public policies. Pre: 2304. (3H,3C)

4334: PERSPECTIVES ON ADDICTION AND FAMILY SYSTEMS
Intra-personal and inter-personal dimensions of compulsive- addictive patterns manifested in the context of the family system. Reciprocal interaction between families and other systems. Junior standing required. Pre: 2304 or 2314. (3H,3C)

4354: FAMILY, LAW, AND PUBLIC POLICY
Theoretical and substantive issues that relate to the development and implementation of family policies. Implications of political culture and family legislation for the well-being of children and their families. Pre: 1004, 2335, 2336, 2004, 2304. (3H,3C)

4354H: FAMILY, LAW, AND PUBLIC POLICY
Theoretical and substantive issues that relate to the development and implementation of family policies. Implications of political culture and family legislation for the well-being of children and their families. Pre: 1004, 2335, 2336, 2004, 2304. (3H,3C)

4364: GENDER AND FAMILY DIVERSITY
Examination of the changing character of individual and family diversity, as related to the intersections among gender, race, class, sexuality, age, and ability. Junior standing required Pre: 2304. (3H,3C)

4714: SENIOR CAPSTONE SEMINAR
Intensive learning experiences in critical thinking and analysis. Opportunities to demonstrate breadth of learning while developing leadership skills and honing professional competencies. Topics include leadership and team development, problem solving, grant writing, program evaluation, and electronic portfolios. Senior standing in Human Services required. Pre: 2336, 4324. (3H,3C)

4964: FIELD STUDY
Variable credit course. Pre: 1004, 2004, 2335, 2336.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

History

Chair: Brett L. Shadle
Associate Chair: Dennis P. Halpin
Professors: M.V. Barrow Jr., L. A. Belmonte, A.R. Ekirch, E.T. Ewing, R.F. Hirsh, B. L. Shadle, and P.R. Wallenstein
Associate Professors: D. Agmon, G.R. Bugh, H. L. Gumbert, M. Heaton, M. Kiechle, M. Mollin, A. Nelson, P. Quigley, P. Schmitthenner, H. Schneider, N.L. Shumsky, R. P. Stephens, D.B. Thorp, and L. Winling
Assistant Professors: A. Demmer, C. Gitre, E. Gitre, D. Halpin, L. Holness, E. Polanco, and J. Taylor
Collegiate Assistant Professor: M. Dufour
Senior Instructor: T. H. Becker
Visiting Assistant Professor: B. Nichols
Adjunct Professors: M. Alexander and R. Shelton

Web: **www.liberalarts.vt.edu/departments-and-schools/department-of-history.html**

Overview

History is the study of people and events of the past to better understand how to meet the challenges of the

future. Our students develop important 21st-century skills in research and analysis, speaking and writing excellence, the synthesis of diverse information, digital and media literacy, intercultural understanding, and historical/contextual expertise.

Widely recognized for promoting undergraduate research, the history curriculum prepares students for fulfilling careers in the technology sector, law, business, the military, intelligence, non-profit management and administration, healthcare, media and communication, information management, and education. History also provides the knowledge and skill students need for graduate work in Journalism, Law, Business, and Medicine, or the liberal arts or social sciences.

Courses at the 1000 level are introductory surveys open to anyone with an interest in history but without a strong background in the subject. Students intending to continue in history should take these courses in their freshman or sophomore years. Courses at the 2000 level, with the exception of Historical Methods, are introductory surveys of particular topics for a general undergraduate audience. Courses at the 3000 level, primarily for sophomores and above, provide more focused and detailed study of a period, place, or topic introduced at the 1000 or 2000 level. Courses at the 4000 level are conducted as seminars that emphasize original writing and research, and are generally restricted to students with junior standing or above who have already taken six hours or more of college-level history.

Majors

The history curriculum is designed to introduce fundamental skills of the discipline, followed by upper division courses that develop knowledge and skills, culminating in a capstone research experience. It is a deliberately flexible curriculum built to encourage students to double major, minor, or undertake study abroad, internships, and/or undergraduate research.

History majors complete a minimum of 36 hours in History, including 18 hours of core history courses and 18 hours of depth studies that can be tailored to students' own interests.

Majors who choose to undertake the Research/Thesis Option will complete the requirements of the B.A. in History and: six hours of undergraduate research that results in the completion of a Thesis, or three hours of undergraduate research that builds on work completed in HIST 4914 and three hours of History elective credit at the 2000 level or above.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Majors may select a concentration within the history major. Concentrations require that at least 12 of the 24 hours of history taken at the 2000 or 3000 level be appropriate to the field of concentration, and the completion of 6 hours of undergraduate research. Concentrations are available in: Military/Political/Diplomatic History; Social/Cultural/Economic History; Global/Comparative History; and History of Science/Technology/Environment.

A faculty advisor and/or professional advisor will assist each major in planning a suitable course of study. The student is expected to confer with the faculty advisor at regular intervals regarding the progress of his or her studies.

To earn a minor in history, a student must complete satisfactorily (with at least a 2.0 average) a minimum of 18 hours of history courses. You may find requirements by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Minors

History minors require completion of a minimum of 18 hours of history courses, some of which must meet a Depth Studies requirement. We offer minors in History, War and Society, Asian Studies, and Russian Area Studies. You may find requirements by visiting the University Registrar website **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Advising

A professional advisor assists each major in planning to meet their degree requirements. The student is expected to confer with the advisor at regular intervals regarding the progress of his or her studies. Students also work with one or more faculty mentors who provide guidance regarding academic and professional choices.

Virginia Tech offers extensive **career advising**.

Experiential Learning

This history department encourages our students to undertake study abroad, internships, and undergraduate research projects and offers students curriculum that allows them to achieve academic credit for these experiences. Check out the wide variety of study abroad programs available through the **Global Education Office**. Research the **wide array of career-related experiences** you can have while still in College, especially **Hokies4Hire**.

Honors

Outstanding history majors may be eligible to join the Honors College and complete an Honors Laureate Diploma. For more about the Honors College, please visit **https://honorscollege.vt.edu**.

Student Organization

The department is host to a student-run History Club and a local chapter of the National History Honors Society Phi Alpha Theta. Social and academic events allow for informal interaction between students and faculty. Don't miss our annual trivia competition Stump the Chumps—the Graduate students are the current champions!

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in history.

Satisfactory progress requirements toward the B.A. in history can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (HIST)

1004: INTRODUCTION TO HISTORY
Introduces students to the main concepts and issues of discipline of history. Familiarizes students with the

Department of History, educational requirements, university resources, and career opportunities for History majors. (3H,3C)

1014: SURVEY OF AMERICAN ECONOMIC HISTORY
Introduction to fundamental issues in history through historical simulations. Enacting specific roles in historical situations while improving liberal learning skills, including evaluating evidence, understanding multiple perspectives, writing persuasive essays, and developing public speaking skills. Specific topics may vary from semester to semester. May be repeated one time with different content for a maximum of six credits. (3H,3C)

1024: ANCIENT HISTORY
Surveys the civilizations and peoples of Greece, Rome, and the Ancient Near East (including Egypt and Mesopotamia) from the invention of writing around 3,000 B.C. to the fall of the Roman Empire in the fifth century C.E. through study of literature as well as archaeological artifacts. Examines the interactions and interdependencies of these civilizations and considers their enduring influence. (3H,3C)

1025,1026: INTRODUCTION TO EUROPEAN HISTORY
Examines the political, social, and cultural history of Europe since the medieval period. Focuses on the complex interplay between demographic transformation, social and political change, and cultural development. 1025: Explores the legacy of the Roman Empire, the expansion and consolidation of "Europe", the medieval world and expansion in the Atlantic World. 1026: Explores the rise of Absolutism and the Enlightenment, the Age of Revolutions, imperialism, the rise of new political ideologies and nation-building, and Europe in the twentieth century world. (3H,3C)

1115,1116: HISTORY OF THE UNITED STATES
Examines the history of the United States through intersections of politics, economics, sciences, the arts and significant social movements. Considers how the modern United States has emerged through the interactions of diverse ethnic, racial, national, class, and religious groups. 1115: pre-Columbian societies through the Civil War; 1116: Reconstruction through present. Sequence recommended as preparation for advanced courses in United States history. (3H,3C)

1214: HISTORY OF THE MODERN WORLD
An examination of the global significance of the critical political, social, cultural, and international issues in the 20th century. (3H,3C)

1215,1216: INTRO TO WORLD HISTORY
Examines political, economic, social, and cultural change around the world over the course of human existence, with particular emphasis on connections and comparisons of human societies across space and time. 1215: Covers early civilizations to 1500 CE. Major themes include the development of human civilization and the interactions of different societies through exchange of people, ideas, goods, and disease. 1216: Covers from 1500 CE to present. Major themes include the spread of European imperialism and resistance to it, development of nation-states, world wars, and post-colonial globalization. (3H,3C)

1224: INTRODUCTION TO LATIN AMERICA
The peoples of Latin America from the earliest times to the present. Historical approach to understanding ancient and contemporary cultures, their environmental impact, and their socio-political dynamics from Mexico to Tierra del Fuego over 5000 years. (3H,3C)

1354: CONFLICT AND SECURITY IN MODERN EAST ASIA
Survey of the 20th century history of five states in northeast Asia, People's Republic of China, Taiwan, Japan, North and South Korea, and the connections between them. Causes and consequences of war, colonization and nationalist movements and their implications for contemporary regional and global relations. Emphasis on cultural concepts, political ideologies, social relations and historical conflicts as background to current security concerns. (3H,3C)

1515,1516: HISTORY OF AFRICA
Examines political, economic, social and cultural themes in African history from the beginnings of human civilization to the recent past, with particular emphasis on historical experiences of race, gender, class, religion, ethnicity, and nationality. 1515: Covers early civilizations through the abolition of the slave trade.

Examines migrations and trade, the expansion of Islam, and slavery in Africa and the Atlantic and Indian Oceans. 1516: Covers Africa since the nineteenth century. Examines European conquest, and major political, cultural and social changes during the colonial and post-colonial eras. (3H,3C)

1984: SPECIAL STUDY
Variable credit course.

2004: HISTORICAL METHODS
Explanation of the discipline of history: its history, philosophies, and methods, with emphasis on historical research. (3H,3C)

2054 (STS 2054): ENGINEERING CULTURES
Development of engineering and its cultural values in historical and transnational perspectives. Explores the varying knowledge, identities, and commitments of engineers and engineering across different countries. Examines values in emergent infrastructures of engineering education and work, and the participation of engineers and engineering in evolving forms of capitalism. Helps students learn to reflect critically on their knowledge, identities, and commitments in varying curricula and a globalizing world. (3H,3C)

2104: TOPICS AND CRITICAL ISSUES IN US HISTORY
Introduction to the problems, methods and skills of the discipline of history through the study of significant themes and critical issues in the history of the United States. Emphasis on the study of source materials and historical interpretations of specific themes in American history. Themes grounded in issues of class, race, gender, and equality in US history. Specific topics will vary from semester to semester. Course may be repeated twice for a maximum of 9 credits. (3H,3C)

2104H: TOPICS AND CRITICAL ISSUES IN US HISTORY
This course allows Honors students to explore more thoroughly selected themes in the history of the United States, from its initial settlement to the present. Students must have University Honors status or permission of the instructor to take this course. (3H,3C)

2114: TOPICS AND CRITICAL ISSUES IN EUROPEAN HISTORY
Introduction to the problems, methods and skills of the discipline of history through the study of significant themes and critical issues in European history. Emphasis on the study of source materials and historical interpretations. Specific thematic content is variable. Themes grounded in European history/Europe's role in world that interrogate the concept of "the West". Specific topics will vary from semester to semester. Course may be repeated twice for a maximum of 9 credits. (3H,3C)

2114H: TOPICS AND CRITICAL ISSUES IN EUROPEAN HISTORY
An exploration of critical issues in modern European history, through the study of source materials and historical interpretations. University Honors standing is required. (3H,3C)

2124: TOPICS AND CRITICAL ISSUES IN WORLD HISTORY
Introduction to the problems, methods and fundamental skills of the discipline of history through the study of significant themes and critical issues in world history. Emphasis on the study of source materials and historical interpretations. Specific thematic content is variable. Examines political, economic, social, and cultural change at historically specific periods of time around the world with a focus on drawing comparisons and making connections across regional spaces. Specific topics may vary from semester to semester. May be repeated two times with different content for a maximum of 9 credit hours. (3H,3C)

2165,2166: HISTORY OF FRANCE
French history from Roman Gaul to the present. 2165: Roman, Medieval, and Renaissance France; Absolute Monarchy. 2166: The Revolution; Nineteenth and Twentieth Century France. (3H,3C)

2184: HISTORY OF THE BALKANS
History of Southeastern Europe from the sixth century to the present. Chief themes are movement of peoples, Byzantine and Ottoman Empires, religious conflicts, social developments, and rival nationalisms. (3H,3C)

2224 (CLA 2224): ANCIENT GREEK AND ROMAN WOMEN
Examines the history of ancient Greek and Roman women from ninth century BCE to the fall of the Roman

Empire. Analyzes contributions of women to each civilization. Studies construction of and contemporary debates about women's ascribed social, political, and cultural roles. (3H,3C)

2234 (CLA 2234): CLASSICS IN THE MODERN WORLD
Examines the influences, traditions, and receptions of the ancient Greeks and Romans in the modern world, especially in the United States. Explores the re-interpretation of the ancient Greek and Roman world across mediums, and by leaders and governments in diverse societies. Discusses contexts and ideologies of re-makings of the ancient Greek and Roman world. (3H,3C)

2275,2276 (AFST 2275, 2276): AFRICAN-AMERICAN HISTORY
2275: African continent through Civil War. Examines trajectory of slavery as well as its global impacts and legacy, the development of racial thought, slave resistance and rebellions, the fight for Emancipation, and African American contributions to culture, economics and society of United States. 2276: Reconstruction through present. Examines impact and legacy of Reconstruction, the fight against Jim Crow segregation, and the social, cultural, political and economic contributions of African Americans in the nineteenth and twentieth century United States. Exploration of the global implications of race relations in the United States. (3H,3C)

2304: AFRICA IN THE MODERN WORLD
The peoples and societies of Africa. Emphasis on major themes and developments since the eighteenth century. Historical approach to understanding indigenous African cultures and their encounters with global forces. Concentration on African achievements, the response to colonialism, the rise of modern nationalism, and the problems and prospects of independent Africa. (3H,3C)

2345,2346: HISTORY OF THE MIDDLE EAST
History of the Middle East from the seventh century to today, with emphasis on formation of Islamic civilization, medieval and early modern political systems, European imperialism, and the struggle for independence. 2345: seventh century to 1914; 2346: independence, wars, revolutions, and social change since 1914. (3H,3C)

2355,2356: HISTORY OF CHINA
China from prehistory to the present. Special attention to political, social, economic, and cultural developments. 2355: Prehistory, Imperial China to the sixteenth century; 2356: late Imperial China to modern and contemporary China. (3H,3C)

2364: HISTORY OF JAPAN
Political, social, economic, and cultural development of Japan from earliest times to present; emphasis on problems of modernization in the nineteenth and the twentieth centuries. (3H,3C)

2374 (RLCL 2374): GODS AND KINGS IN PREMODERN INDIA
History of India from pre-historical times to approximately 1700, with particular focus on the interplay between religion and politics. Emphasis on sources for and interpretations (historiography) of early Indian history. Literary versus archaeological record of pre-historic India, the earliest empires and rulers, and impact of the Islamic and wider world on India. Legacies of ancient and medieval India in the contemporary world. (3H,3C)

2384 (RLCL 2384): GANDHI IN THE MAKING OF MODERN INDIA
History of India since approximately 1700, with particular focus on Gandhi’s influence on modern India and the world. Emphasis on sources for and interpretations (historiography) of modern Indian history. Examination of pre-colonial and colonial pasts and legacies. Exploration of Gandhi’s role in political, social, cultural, and religious movements of the early 20th century, and Gandhi’s legacy in the independent states of South Asia and the contemporary world. (3H,3C)

2484: MODERN GERMANY
Political, social, economic, and cultural history of Germany since 1815. Discussion of the origins, experience and impact of political ideologies and national unification/reunification, colonial expansion, Nazism, war and genocide, and the role of Germany in Europe and the world. Diverse perspectives on German history and its implications through primary and secondary source materials. Particular focus on historiographical interpretations of the German past. (3H,3C)

2604 (SOC 2604) (STS 2604): INTRODUCTION TO DATA IN SOCIAL CONTEXT
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics,

diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures. (3H,3C)

2715,2716 (STS 2715, 2716): HISTORY OF TECHNOLOGY
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens' groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2984H: SPECIAL STUDY
Variable credit course.

3004: COLONIAL AMERICA
Critical analysis of early American society. Founding and development of the colonies in the 17th century; 18th century colonial life. (3H,3C)

3014: THE AMERICAN REVOLUTION
Causes, nature, and results of the American Revolution, 1763- 1789. (3H,3C)

3054: THE AMERICAN CIVIL WAR
Causes, course, and consequences of the American Civil War. Emphasis on transformations in regional and national identity, race relations, the status of African Americans, gender roles, military affairs, and the United States' place on the world stage. Develop skill in written and oral discourse. (3H,3C)

3064: EMERGENCE OF MODERN AMERICA, 1877-1917
America from end of Reconstruction to World War I: industrial and urban growth, the last frontier, worsening status for African-Americans, immigration and new ethnic currents, Populism and Progressivism, cultural ferment, overseas expansion, and America's entry on the world stage. (3H,3C)

3084: RECENT AMERICA, 1917-PRESENT
Social, economic, cultural, and political history of America from the entry into World War I, the turbulent 1920's, the Great Depression, the New Deal, World War II, postwar prosperity, the Cold War, social and cultural ferment, Vietnam, Watergate, to the new anxieties about the limits of power in the 1980's. (3H,3C)

3104: UNITED STATES SOCIAL HISTORY
Examination of the lives of ordinary people in order to understand the human experience through a focus on race, ethnicity, class, gender, and region. (3H,3C)

3105,3106: WOMEN IN U S HISTORY
Roles of women from colonial settlement to the present. Special attention to family experiences, political agendas, and economic contributions of women and to social construction of gender identities. 3105: to 1865; 3106: since 1865. (3H,3C)

3114: HISTORY OF CAPITALISM
Examines the changing economic and political conditions under capitalism since the Industrial Revolution.

Outlines key ideas and figures that shaped the system of capitalist accumulation and industrial production. Identifies changes in systems of production, exchange, labor, and distribution and distinguishes between organizational innovations, technological advancements, and political responses. Discusses the ethical and moral implications and consequences of state policies, economic exchanges, and individual actions in the capitalist creation and distribution of wealth and various critiques of the system. (3H,3C)

3134: SPORTS IN AMERICAN HISTORY
Impact of sports in American history. Emphasis on the impact of team sports (college and professional basketball, baseball, and football) and individual sports (golf, boxing, and automobile racing) on the development of American society and culture. (3H,3C)

3144: AMERICAN ENVIRONMENTAL HISTORY
Explores interactions between Americans and the environment from the time of European contact to the recent past. Traces the sometimes unexpected ways in which nature has shaped history, humans have altered the natural world, environmental attitudes have evolved, and environmental inequalities have arisen. (3H,3C)

3155,3156: HISTORY OF AMERICAN CITIES
Growth and development, form and functioning of American cities from the settlement of the country to the present. 3155: 1565 to 1870. 3156: 1870 to the present. I,II (3H,3C)

3164: SEXUALITY IN AMERICAN HISTORY
Examines the changing social and cultural meanigns of sexual behavior and identity in American life from the colonial era to the present. Explores relationships between sexuality and power, culture and politics, and government regulation with consideration of theoretical frameworks of interpretation. Focuses on dynamics of race, ethnicity, gender, and class. (3H,3C)

3205,3206: U.S. SOUTH
The southern experience from Old to New South with emphases upon racial accommodation, social hierarchy, cultural identity, political struggle, and intellectual change. 3205: to 1900; 3206: since 1900. (3H,3C)

3214: HISTORY OF APPALACHIA
Early settlement, religion, the pre-industrial economy, the coming of the coal and lumber industries, labor activism, politics, migration, and regional identity. (3H,3C)

3224: HISTORY OF VIRGINIA
Social, political, cultural, and economic developments in Virginia, from the sixteenth century to the present. (3H,3C)

3234: THE NORTH AMERICAN WEST
A study of the peoples and history of the North American West from the sixteenth century through the twentieth. (3H,3C)

3254: THE VIETNAM WAR
A critical study of the causes and consequences of the Vietnam War, 1945-1975. Analysis of America’s strategic and military objectives, the nature and conduct of the war, and the growth of the antiwar movement at home. (3H,3C)

3274: THE GREEK CITY
History of the ancient Greek city-state (polis) from the Archaic period (800-500 BC) to the creation of the Roman Empire. Principal topics are: origins and definition of the polis; Greek colonization throughout the Mediterranean and Black Seas; the struggle for autonomy in the Classical and Hellenistic periods; and the Hellenizing impact of the polis on non-Greek populations. (3H,3C)

3284: THE ROMAN REVOLUTION
History of the Roman world from 264 B.C. to A.D. 180. Particular attention to the three themes of imperialism, revolution, and empire through extensive reading of the contemporary authors. (3H,3C)

3294: ROMAN BRITAIN
Examines the social, political, and military origins of early England from Stonehenge to the Norman Conquest;

emphasis on archaeology and material culture; and the legacy of the Romans and Romanization on forging a British identity. (3H,3C)

3304: THE WORLD OF ALEXANDER THE GREAT
Examines the life and times of Alexander the Great and the Hellenistic World, a new cosmopolitan multicultural world initiated by his conquests. Analyzes the rise of Mecedon, the accomplishments and powers of Alexander, and discusses the world forged after him through analysis of literary and non-literary primary sources. (3H,3C)

3314: THE LATER ROMAN EMPIRE
Roman Empire in the west from A.D. 180 to A.D. 476 and in the east from A.D. 476 to A.D. 1071. Particular attention to the causes of the fall of the empire in the west and to the Byzantine Empire in the east until the coming of the Turks and the Christian Crusaders. (3H,3C)

3324: THE MEDIEVAL WORLD
Characteristic thought and institutions of high and late Middle Ages. (3H,3C)

3334: THE RENAISSANCE
The Italian Renaissance in its European context. Emphasis upon the culture and institutions of Italian states from 1300 to 1500. II (3H,3C)

3344: THE ERA OF THE REFORMATION
Development of Protestantism and reformation of the Catholic Church from 1500 to about 1600. Emphasis upon social, political, and economic factors as well as theology. Examination of conflicts engendered by the reformation movements. (3H,3C)

3364: THE AGE OF REVOLUTION AND NAPOLEON
The French Revolution in its European and global context, with particular attention to social and political causes of unrest, strategies of popular mobilization, debates about authority and order, the emergence of empires, and the long-term implications of revolutionary change. (3H,3C)

3374: FRENCH EMPIRE
History of French empire from the seventeenth century to the present, in the Carribean, Canada, Asia, North America and Sub-Saharan Africa. Considers indepdendence movements and the effects of post-colonial migrations on metropolitan France. Focus on issues of religion, race, and human rights (3H,3C)

3394: EUROPE SINCE WORLD WAR II
Europe’s political and economic recovery since 1945; development of the "Cold War"; Soviet Union and Eastern Europe before and after Stalin; Western European integration and development of a consumer society; Ostpolitik and Detente; decolonization and neo-colonialism; Europe’s position in the world economy, dependence on imported materials and energy; the Revolutions of 1989 and post-Marxist Eastern Europe. (3H,3C)

3424: TUDOR AND EARLY STUART ENGLAND, 1509-1660
Causes and consequences of the English Reformation and subsequent Civil War. Decline of royal power and increasing importance of Parliament. Cultural and intellectual developments of the Elizabethan period. (3H,3C)

3484: NAZI GERMANY: HISTORY AND MEMORY
Causes, course, and consequences of the rise of National Socialism in Germany. Political, economic, social, and cultural aspects of life in Germany. Conditions of Weimar Germany; fascism; the emergence of the Nazi Party and its acquisition, exercise and abuse of power; transformation of German society; the problem of Hitler; the Second World War and Holocaust; and memory and representation of the Nazi period. (3H,3C)

3494 (JUD 3494) (RLCL 3494): THE HOLOCAUST
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovah’s Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary

sources: written accounts, photographic and film, and personal testimony. (3H,3C)

3504 (RLCL 3504): THE AGE OF THE CRUSADES
The origins and development of religious violence examined from an interdisciplinary and cross-cultural perspective; the place of that phenomenon in medieval society. Christianity, Islam, Judaism and their interactions in the medieval world. (3H,3C)

3524: EUROPEAN MILITARY HISTORY TO 1789
Analysis of change in warfare from the ancient Greeks to the French Revolution. Emphasis on the social and technological causes of military change. (3H,3C)

3534: MODERN MILITARY HISTORY
Evolution of warfare in its political and social setting since the French Revolution. Discussion of both European and American military institutions. (3H,3C)

3544: WORLD WAR II
Examines the origins, nature, and consequences of the Second World War in transnational perspective. Discussion of social, economic, political and diplomatic conditions that led to and shaped the conduct of the war. Engagement with diverse perspectives on the war and its implications through primary and secondary source materials. (3H,3C)

3554: AGE OF GLOBALIZATION
An examination of historical forces that have shaped patterns of globalization, with emphasis on the late twentieth and twenty-first centuries. Key themes: debates about the origins of globalization, causes and consequences of global inter-relatedness, influence of key people, events, and ideas on patterns of globalization, and the effects of disease, technology and environment on processes of globalization. (3H,3C)

3564: THE COLD WAR
Examines politics, society, and culture of the Cold War in transnational perspective. Discussion of origins of the Cold War and the emergence of "superpowers;" cultural, economic and territorial imperialism in the Cold War; the role of ideology; lived experience and the legacy of the Cold War. Engagement with diverse perspectives on the Cold War and its implications through primary and secondary source materials. (3H,3C)

3584: COLONIAL LATIN AMERICA
Major themes and issues in Colonial Latin American History. Discussion of the Spanish and Portuguese empires in the western hemisphere, emphasizing indigenous responses to colonization, the privatization of land and labor, the Church and village as financial and cultural institutions, imperial policies and reforms, and the collapse of empire after 300 years. I (3H,3C)

3594: THE RISE OF MODERN LATIN AMERICA
Major themes and issues in Modern Latin American History. Discussion of the rise of Latin American nations, stressing the internal and external challenges new republics confronted during the nineteenth century and the opportunities and conflicts of the twentieth century. (3H,3C)

3604: RUSSIA TO PETER THE GREAT
Russian history from the founding of Russia in the ninth century to the reign of Peter the Great in the early eighteenth century, with special attention to political developments, changes in society and culture and regional context. (3H,3C)

3614: IMPERIAL RUSSIA
Russian history from Peter the Great to the Revolution of 1917, with special attention to political developments, changes in society and culture, and the impact of the regional context. (3H,3C)

3624: HEALTH AND ILLNESS IN AFRICAN HISTORY
Examines key subjects and themes in the history of health, medicine, and disease in African history. Topics include indigenous health systems, colonial medicine, and post-colonial health crises, including HIV/AIDS. (3H,3C)

3634: MAU MAU: COLONIALISM AND REBELLION IN KENYA

Examines the social, political, economic, and cultural origins of the Mau Mau rebellion in Kenya; insurgency and counter-insurgency; and the continuing debates in Kenya over the meaning of Mau Mau. (3H,3C)

3644: TWENTIETH-CENTURY RUSSIA
The history of the Soviet Union from 1917 to the present, with particular emphasis on collectivization, industrialization, ideology, international relations, and other factors that have determined the peculiar character of the Soviet state. (3H,3C)

3654: ARAB-ISRAELI CONFLICT
Examines the origin and evolution of the Arab-Israeli Conflict from the late Ottoman era to present. Considers a variety of perspectives on the major events, places, people and history of the conflict, including the British Mandate period, independence, and post-1967. Connects the relationship between events and ideas in Palestine/Israel and their local, regional and global significance through analysis and synthesis of primary and secondary texts. Promotes interpretation of the conflict and potential solutions in written and oral form, both from the student's own and alternative points of view. (3H,3C)

3664: REVOLUTIONARY CHINA
Ideological and institutional development of the Chinese Communist movement since 1920; emphasis on problems of historical change in modern China. (3H,3C)

3674: TOPICS IN CHINESE HISTORY
Examination of variable topics in Chinese history, ranging from the beginnings of civilization to the recent past. Examines the primary sources and histriographic debates of a particular issue. Explores the diversity within China and its relatiionship with the rest of the world. Can be repeated with different content up to 9 hours. (3H,3C)

3684: CULTURAL HISTORY OF THE SOVIET UNION AND THE SUCCESSOR STATES
History and main characteristics of cultural life and the arts in the former Soviet Union, with emphasis on film, music, literature, and the relationship between elite and popular culture. (3H,3C)

3694: HISTORY THROUGH FILM
This course introduces students to critical issues in history and representation, utilizing film to analyze central historical issues. The specific thematic content is variable. Course may be repeated for up to 9 credits. (2H,3L,3C)

3705,3706 (STS 3705, 3706): HISTORY OF SCIENCE
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science. (3H,3C)

3714: WAR AND MEDICINE
Examines the relationship between war and medicine. Focus on suffering and care during and after major conflicts, both on the battlefield and the home front. Emphasis on race, class, and gender. (3H,3C)

3724: HISTORY OF DISEASE, MEDICINE, AND HEALTH
Development of Western concepts and institutions of disease, medicine, and health with emphasis on nineteenth century to present. Social construction of disease, and relationship between health and social, economic, and political structures. Special attention to roles of race, class, gender and ethical issues in medical care and research, and to the lived experience of suffering, treatment and healing. (3H,3C)

3734 (STS 3734): HISTORY OF MODERN BIOLOGY
This course explores the development of biology from the Enlightenment to the end of the twentieth century, with a particular emphasis on biology’s impact on society. (3H,3C)

3744: SOCIAL HISTORY OF FILM
This course introduces students to critical issues in the social history of film, examining the production and consumption of film in specific historical moments as well as the effects of film on society, culture, and politics. The specific thematic content is variable. May be repeated with different content for a maximum of 9 credits. (3H,3C)

3754: PUBLIC HISTORY
Investigation of the ways in which historians research, interpret, and present the past to the public. (3H,3C)

3764: ORAL HISTORY: METHODS AND PRACTICES
Explores the theory and methodology of oral history practice. Considers the use of oral history interviews in historical research, and explores questions of ethics, interpretation, and the construction of memory. Includes training in technical operations and a variety of interview techniques, transcription, and historical use of interviews. (3H,3C)

3774: DIGITAL HISTORY
Develops skills and methods for researching and presenting history in a digital environment, with special emphasis on use of digital media as a tool for public historians. (3H,3C)

3864 (AFST 3864) (IS 3864): DEVELOPMENT AND HUMANITARIANISM IN AFRICA
Examines the history of western development and humanitarian projects in Africa, considering western and African perspectives in the nineteenth and twentieth centuries. Discussion of slavery and abolition, the civilizing mission, modernization and development theory, the impact of humanitarian projects, and international volunteerism. Provides a foundation for students interested in international service learning or careers with NGOs or international aid agencies. No prior knowledge of African history required. (3H,3C)

3914: CRITICAL READING AND ANALYSIS IN HISTORY
Develops critical reading skills in history. Demonstrates that historical knowledge is part of a scholarly conversation that grows and evolves over time. Assesses the critical role of interpretation in history, investigates historical controversies and debates, and develops skills to evaluate historiographical trends. Pre: 2004. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4004: TOPICS IN SOCIAL AND CULTURAL HISTORY
Selected topics in social and cultural history. May be repeated with different content. 3 other hours of history and junior standing required. Pre: 2004. (3H,3C)

4914: HISTORY RESEARCH SEMINAR
Variable topic, writing-intensive, capstone course for history majors. Provides in-depth knowledge of a specific historical subfield. Utilizes archival historical sources, online research databases, and existing literature to create an original work of historical scholarship. May be repeated with different content up to 6 hours. Junior standing or above required. Pre: 3914 or 3904. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Human Nutrition, Foods, and Exercise

Head: Matthew W. Hulver
Professors: B. Davy, K. Davy, D. Liu, M. Hulver, E. Serrano, and J. Williams
Associate Professors: D.J. Good, R.W. Grange, E.M. Schmelz, and Y.H. Ju
Assistant Professors: S. Craige, M. Frisard, S. Harden, V. Hedrick, V. Kraak, C. Rafie, and J. Stein
Collegiate Assistant Professors: A. Anderson
Senior Instructor: C.B. Papillon and H. Cox
Advanced Instructor: R. Eaton and N. Girmes-Grieco
Instructors: K. Chang and M. Rockwell
Adjunct Instructors: J. Gustafson

Web: **www.hnfe.vt.edu**

Overview

Human nutrition, Foods and Exercise (HNFE) is a unique field of study that builds on the biological, physical, and social sciences. Many health issues including obesity, heart disease, and cancer have been associated with a person's food intake and level of exercise. This has led to increasing emphasis on health promotion and disease intervention, and the nutrition and exercise professionals are integral members of the health care team. Expanding research by private and government agencies focusing on the role of nutrition and physical activity in health, growth, and aging has created a demand for graduates at the B.S., M.S., and Ph.D. levels who have a background and interest in laboratory and experimental methods in nutrition, foods and exercise science. Faculty and staff in HNFE include interdisciplinary teams that work towards molecular and clinical advances for the prevention and improved treatment of chronic diseases, behavioral discoveries that lead to effective intervention programs for youth and adults, and speed the movement from research to practice.

There are two options from which an undergraduate student majoring in human nutrition, foods and exercise may choose: Dietetics (DIET) or Science of Food, Nutrition and Exercise (SFNE).

The department participates in the University's Honors Program (see "**Academics**" in this catalog).

The Department of Human Nutrition, Foods and Exercise at Virginia Tech offers Master's and Doctoral degrees in specialized areas as they relate to nutrition, physical activity, and health. Graduate students may earn a M.S. or a Ph.D. in HNFE with an emphasis in Molecular and Cellular Science, Clinical Physiology and Metabolism, or Behavioral and Community Science. HNFE also offers a M.S. in Nutrition and Dietetics. Completion of the M.S. in Nutrition and Dietetics leads to eligibility to become a Registered Dietitian.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will

not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Dietetics

Consult: Heather K. Cox

The undergraduate Dietetics option leads to a Bachelor of Science degree in Human Nutrition, Foods and Exercise. This option is a Didactic Program in Dietetics (DPD), fully accredited by the Standards of Education of the Accreditation Council for Education in Nutrition and Dietetics (ACEND). ACEND is the accrediting arm of the Academy of Nutrition and Dietetics. Following completion of the B.S. degree, a student has earned an ACEND Verification Statement. A student must then complete a dietetics supervised practice program (i.e. dietetic internship, graduate dietetics program, etc.) to be eligible for the Registration Examination for Dietitians (RD). The supervised practice requirement can be met through any ACEND accredited program. Graduates from the Dietetics option are competitive applicants for the varied ACEND accredited supervised practice programs.

The dietetics program prepares graduates to assume a professional role in health care, research, the business environment or to pursue graduate studies. Upon completion of a dietetics supervised practice program, alumni are eligible to become registered dietitians (RD). Clinical RDs in hospitals and out-patient clinics provide care to individuals with disease-related nutritional problems. Community RDs work in health clubs specializing in sports nutrition, in work site wellness programs, or in community programs serving mothers and children, low-income families, or elderly people. Business focused RDs work for food and grocery companies, companies manufacturing nutritional supplements, and may represent medical or health products. Administrative RDs with management interests find positions in food service management in a variety of settings such as health care facilities, college or university dining, or hotels and resorts. Registered Dietitians counsel people of all ages, cultural and ethnic backgrounds, and levels of education.

Students in the Dietetics option must maintain an overall GPA of 3.0 to remain in this option. Students who want to change their major into the Dietetics option with HNFE must have an overall GPA of 3.0. Please see the Satisfactory Progress section for additional requirements.

Science of Food, Nutrition, and Exercise

Consult: Renee Eaton

Upon completion of this option a student is well prepared for graduate work in any area of nutrition, exercise physiology or related sciences. This option also meets admission requirements for medical, dental, physical therapy, pharmacy, physician assistant, athletic training and other health professions programs. This option allows students flexibility to tailor the degree toward long term goals including continued education in a health profession or employment. Students who enter the workforce have position titles such as clinical technician, fitness and health program coordinator, clinical research coordinator, medical scribe, surgical technician, rehabilitation aide, hospital recruiting specialist, exercise physiologist, health coach, strength and conditioning coach, and health educator. Students in this option gain knowledge, skills, and abilities specified by the American College of Sports Medicine for certification as a Certified Health Fitness Specialist and Exercise Physiologist. With the growing attention to the role of nutrition and exercise in health promotion and disease prevention, this option is especially appropriate for the student preparing for a career in medicine, physical therapy, or a related health field. The majority of students in the Science of Food, Nutrition and Exercise option plan to attend graduate or professional school.

Students in the SFNE option do not meet the ACEND requirements for a degree in dietetics and therefore do not earn a DPD Verification Statement. Students may choose to earn both the Dietetics and

SFNE options in the department.

Satisfactory Progress

An HNFE student will be considered to have made satisfactory progress toward the degree when he/she has successfully completed:

- In-major GPA â?¥ 2.5 or higher.
- Overall GPA â?¥ 3.0 or higher (Dietetics option) or â?¥ 2.5 or higher (SNFE option)
- Grade of C or better in HNFE 1004, CHEM 1035, CHEM 1036 and CHEM 2535 or 2514.
- These courses must be completed by the time the student has attempted 72 hours:
    - BIOL 1105-1106 or equivalent
    - CHEM 1035-1036 or equivalent
    - CHEM 2535 or 2514
    - HNFE 1004

Students not meeting Satisfactory Progress will have one probationary semester in which to resolve their standing.

Restricted Major status: Current Virginia Tech students who wish to change majors into HNFE (or add as a 2nd major) will be required to have an overall GPA at or above 2.5 (3.0 for Dietetics and double option), have completed CHEM 1035 with a grades of C or higher, and create a plan of study that demonstrates how the student will attain Satisfactory Progress in regards to coursework. The GPA threshold of 2.5 (3.0 for Dietetics option) will stand for all students regardless of transfer status. Satisfactory progress towards degree is enforced.

Undergraduate Course Descriptions (HNFE)

1004: FOODS, NUTRITION AND EXERCISE
Scientific information applied to current concerns in foods, nutrition and exercise as it affects the nutritional health well-being of humans. I,II (3H,3C)

1114: ORIENTATION TO HNFE
An introduction to the academic and career planning for students in the Human Nutrition, Foods & Exercise major. (1H,1C)

1214: TOPICS IN LIFETIME ACTIVITIES
Participation in physical activity, fitness assessment, motor skill development. Awareness and development of the physical, spiritual, emotional, social, and intellectual components of wellness. Application of healthy lifestyle choices for improved quality of life. May be repeated with varying content, for a maximum of 6 credits. Pass/Fail Only Pass/Fail only. (3L,1C)

1264: RACQUETBALL
This course will provide basic instruction in the fundamentals of racquetball. Pass/Fail only. (3L,1C)

1804: PRINCIPLES OF SPORT SCIENCE
Introduction to the principal concepts of improving human physical capacity through sport, exercise training and diet. Emphasis on critical thinking and evidence-based decision making in describing the limits to human performance, responses, adaptations, and health benefits of exercise. (3H,3C)

2004: PROFESSIONAL DIETETICS
Introduction to the profession of dietetics with emphasis on competencies, preparation, and responsibilities associated with dietetic practice. Overview of the structure of The American Dietetic Association (ADA) and its relationship to the dietetic professional. Discussion of current professional concerns. II Co: 2014. (1H,1C)

2014: NUTRITION ACROSS THE LIFE SPAN

Nutritional requirements and related health concerns of pregnant and lactating women, infants, children, adults and the elderly are studied in relation to the physiological and metabolic aspects of pregnancy, lactation, growth and development, maintenance of health, prevention of disease, and aging. 1 year of biology or chemistry required. CHEM 1056 may be substituted for co-requisite CHEM 1036. Pre: 1004, CHEM 1035. Co: CHEM 1036. (3H,3C)

2014H: NUTRITION ACROSS THE LIFE SPAN
Nutritional requirements and related health concerns of pregnant and lactacting women, infants, children, adults and the elderly are studied in relation to the physiological and metabolic aspects of pregnancy, lactation, growth and development, maintenance of health, prevention of disease, and aging. 1 year of biology or chemistry required. CHEM 1056 may be substituted for co-requisite CHEM 1036. Pre: 1004, CHEM 1035. Co: CHEM 1036. (3H,3C)

2204: MEDICAL TERMINOLOGY
Structure, pronunciation, and use of medical terms; anatomical structures and body systems; terms used in pathology, testing, diagnosis, surgery, pharmacology and treatment. Pre: (BIOL 1005 or BIOL 1105 or BIOL 1205H), (BIOL 1006 or BIOL 1106 or BIOL 1206H) o r ISC 2106. (3H,3C)

2224: FOOD SELECTION AND PREPARATION LABORATORY
Principles of food preparation and the effect on food quality determined by objective and sensory evaluation. Food choices at the market and consumer consumption and utilization. I,II Pre: (CHEM 1036 or CHEM 1056), HNFE 1004. Co: 2234. (3L,1C)

2234: FOOD SELECTION AND PREPARATION
Principles of the selection and preparation of foods with emphasis on the preparation and the effect on flavor, texture, and nutritive properties of food. I,II Pre: (CHEM 1035 or CHEM 1055), (CHEM 1036 or CHEM 1056), HNFE 1004. Co: 2224. (2H,2C)

2254: EXERCISE LEADERSHIP - GROUP FITNESS INSTRUCTOR
Development of theoretical and practical skills for leading exercise in a group setting. Topics include: general guidelines for instructing safe, effective, and purposeful exercise, essentials of the instructor-participant relationship, the principles of motivation to encourage adherance in the group fitness setting, effective instructor-to-participant communication techniques, methods for enhancing group leadership, and the group fitness instructor’s professional role. Obtain knowledge of programming for multiple populations. Will complete a CPR and AED certification as a part of in-class instruction. Pass/Fail only. Pass/Fail only. (2H,3L,3C)

2264: EXERCISE LEADERSHIP- PERSONAL TRAINER
Development of practical skills for conducting one-on-one exercise sessions for general healthy adults and special populations. Exercise selection, testing, training principles, and behavioral change skills required to be an effective personal trainer. Preparation for a nationally accredited personal training certification. CPR and AED certification. Pass/Fail only. Pass/Fail only. (2H,3L,3C)

2314 (SPIA 2314): ACTIVE TRANSPORTATION FOR A HEALTHY, SUSTAINABLE PLANET
Connections among active transportation (e.g., bicycling, walking) and significant global challenges such as physical inactivity, health, the environment, and the economy on local to global scales. Methods to assess walkability among communities with different worldviews and the influence of the built environment on rates of active transportation. Approaches to evaluate demographic and psychosocial predictors and physical and policy barriers to use of active transportation. Successful strategies to increase active transportation through community design guidelines, behavior change tools, transportation planning, and policy. (3H,3C)

2334: INTRODUCTION TO INTEGRATIVE HEALTH
Introduction to the principles of integrative health that promote health and well-being. Examination of the person- centered integrative health treatment methods including holistic stress management, the human spirit, communication, energy healing, elements of meditation, healing environments, Chinese medicine, Ayurvedic medicine, voice work, nutrition, therapeutic massage and bodywork, and healing effects of physical activity. Review of scientific evidence of integrative treatments. (3H,3C)

2544 (FST 2544): FUNCTIONAL FOODS FOR HEALTH
Introduction to functional foods (foods with additional value beyond basic nutrition) including development of functional foods, novel sources, and traditional foods with value-added health benefit; regulatory issues; and media messages. (3H,3C)

2664: BEHAVIORAL THEORY IN HEALTH PROMOTION
Introduction to behavioral theories used to design, implement and evaluate health promotion programs, and theories underlying health behavior change. Interactions between individuals, physical and social environments, interpersonal, and intrapersonal determinants of health behavior. Epidemiological evidence of benefits of healthful eating and physical activity. (3H,3C)

2774: TOPICS IN HNFE
A variable-content course. Explores significant contemporary topics in the areas of nutrition, foods, exercise and health. May be repeated for up to six credits. Variable credit course. Pre: 1004.

2804: EXERCISE AND HEALTH
Introduction to the foundations of exercise science as applied to healthy living, and the concept of exercise as medicine. Fundamentals of health appraisal, foundations of fitness training principles and prescription; nutrition and energy cost, and application of exercise prescription for disease prevention and treatment. Pre: 1004, BMSP 2135. (3H,3C)

2824: PREVENTION AND CARE OF ATHLETIC INJURIES
An introduction to the techniques and principles of athletic training. I,II. (1H,3L,2C)

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3014: FOOD, NUTRITION AND WELLNESS STUDY TOUR
Study of emerging career opportunities in industry, government, and other nonprofit agencies, health care, consumer education, and research for students in foods, nutrition or exercise science. Special emphasis on program or product development, evaluation, and marketing as related to a target consumer group. Seminars on campus and at prearranged locations during the two day tour. Junior standing or permission; HNFE majors only. II. (1H,1C)

3024: SCIENCE OF FOOD PREP LAB
Application of the principles of food science and food preparation techniques related to health promotion, disease prevention, and disease management. Selection, production, and evaluation of foods and beverages. Emphasis on experimentation illustrating chemical and physical reactions, sensory and physical properties, nutrient manipulation, cooking applications, and functions of foods. Pre: 1004, CHEM 1036, FST 2014. (1H,3L,2C)

3034: METHODS OF HUMAN HEALTH ASSESSMENT
Evidence-based practice in areas of human health assessment including: anthropometric measurements, vital signs, body composition, aerobic capacity, muscular strength, energy requirements, and health behaviors. Comparison and analysis of assessment methods. Pre: 1004, 2014, BMSP 2136. (1H,3L,2C)

3114: FOODSERVICE AND MEAL MANAGEMENT
Foodservice and meal management for the dietetics professional. Emphasis is placed on understanding food procurement, production, distribution, and marketing in a safe and well managed operation. I Pre: 3024 or 2224. (3H,3L,4C)

3224: COMMUNICATING WITH FOOD
Development of oral and written communication skills to communicate food and nutrition information to diverse populations. II Pre: (2014 or 2014H), (3024 or 2224). (2H,3L,3C)

3634 (PHS 3634): EPIDEMIOLOGIC CONCEPTS OF HEALTH AND DISEASE
Designed to give students in the health sciences a basic understanding of the modern concepts regarding health and disease as well as skills in organizing epidemiological data, disease investigation and surveillance. Includes a survey of terms, concepts, and principles pertinent to epidemiology. Lifestyles of populations and the relationships between lifestyles and health status are studied. II. (3H,3C)

3804: EXERCISE PHYSIOLOGY
Effects of exercise on physiology: neuromuscular, metabolic, cardiopulmonary. Scientific basis of physical training. I Pre: (BIOL 2405, BIOL 2406) or (BMSP 2135, BMSP 2136). (3H,3C)

3824: KINESIOLOGY
The anatomical and biomechanical basis of human motion, with applications for motor skill acquisition, and development and rehabilitative exercises. I Pre: (BIOL 2405, BIOL 2406) or (BMSP 2135, BMSP 2136), (PHYS 2205 or PHYS 2305). (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4004: SEMINAR IN HNFE: WRITING AND DISCOURSE IN THE MAJOR
Focused review of relevant and current literature in selected areas of food, nutrition and exercise. Develop practical strategies for finding research articles on specific topics utilizing a variety of search tools (e.g., library, on-line search engines, etc.). Develop analytical skills to critically assess the significance of published research data. Develop competence in written and verbal presentation of current research in formats suitable for a scientific or a lay audience. Pre: COMM 2004 or ALCE 3634. Co: 4025. (3H,3C)

4024: EMERGING ISSUES IN DIETETICS
Investigation of emerging dietetics topics including professional development, new technologies, current legislative issues, and promising evidence-based practice strategies. Integration of knowledge from previous courses to support quality dietetics practice will be emphasized. Pre: 4026. Co: 4125. (1H,1C)

4025-4026: METABOLIC NUTRITION
4025: Study of bioenergetics and macronutrients, with emphasis on sources, interrelationships, and factors affecting utilization and metabolism. Emphasis on how carbohydrates, lipids, and proteins are metabolized following a meal, during fasting conditions, and when exercising. How metabolism of carbohydrates, lipids and proteins affects and is effected by metabolic disease such as obesity and diabetes will also be examined. 4026: Study of essential vitamins and minerals and their interaction with body systems, especially as these relate to food, exercise and health. Emphasis on how deficiency, toxicity and genetic conditions affect various organ systems, including bone, skin, digestive, and blood. Historical and regulatory policies, and scientific studies establishing recommended dietary allowances for micronutrients are considered. Pre: (2014 or 2014H), BMSP 2136, (BCHM 2024 or BCHM 3114 or BCHM 4115) for 4025; 4025 or 3025 for 4026. (3H,3C)

4114: FOOD AND NUTRITIONAL TOXICOLOGY
Principles of food and nutritional toxicology with primary emphasis on food components and food toxins including absorption, metabolism and excretion. An overview of types of adverse food reactions including food allergy, food sensitivity, and food intolerance. An overview of U.S. and international lawas and regulation of safety assessment of foods including food additives, dietary supplements, and residues of contaminants, pesticides, and antibiotics. Analysis of food and nutritional toxicity cases in the context of the food system, regulatory policies, and public communication. Pre: BMSP 2136, BCHM 2024. (3H,3C)

4125-4126: MEDICAL NUTRITION THERAPY
Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. 4125: Emphasis on the relationship between principles of nutritional care and the medical treatment of individuals with selected diseases or clinical problems. 4126: Integration of knowledge of pathophysiology, biochemical, and clinical parameters, medical treatment and nutrition therapy for patients with selected clinical problems/disease states. Pre: 2004, 4026 for 4125; 4125 for 4126. Co: 3034 for 4125. (3H,3C)

4134: EXPERIENTIAL APPROACH TO NUTRITIONAL THERAPY
Use of didactic and experiential methods to learn and apply theories of behavior change in diverse nutrition counseling situations. Pre: Instructor approval. I Pre: 4644. Co: 4125. (2H,2C)

4174: NUTRITION AND PHYSICAL PERFORMANCE
Nutritional requirements for the wellbeing and optimal performance of athletes. Methods of assessment and modification of diet, performance, and body composition in athletes. Evaluation of dietary ergogenic aids and supplements for performance and body composition. Pre: 2804. Co: 4025. (3H,3C)

4224: ALTERNATIVE AND COMPLEMENTARY NUTRITION THERAPIES
Critical evaluation of health claims, mechanisms of action, and research literature for a wide variety of alternative nutrition therapies used for disease prevention and treatment. Practical application of knowledge through completion of problem-based learning projects. Pre: (BIOL 1005 or BIOL 1105 or BIOL 1205H), (BIOL 1006 or BIOL 1106 or BIOL 1206H), (CHEM 1036 or CHEM 1056). (2H,2C)

4254: EXPERIMENTAL FOODS
Experimental study of the functions of ingredients and factors affecting food quality with emphasis on an independent project. Pre: 3234. (1H,3L,2C)

4514: NUTRITIONAL GENOMICS
Interactions between foods and nutrients with genetics, genomic DNA, and gene expression in humans and animals. Genetic variants that affect optimal health, metabolism and nutrition in individuals, as well as inheritance of these variants in individuals, and allele frequencies in populations. Scientific, ethical, and legal considerations of genes and nutrition knowledge, personalized testing, and genetic engineering. Junior standing. (3H,3C)

4624: COMMUNITY NUTRITION
The application of nutrition principles to an analysis of current applied nutrition programs and a study of the political and legislative processes affecting the practice of dietetics. I Pre: (2014 or 2014H), 4026. (3H,3C)

4634: SOCIO-CULTURAL FOOD SYSTEMS
Study of social, cultural, and economic aspects of food systems, using quantitative and qualitative methods to assess nutritional status. Pre: 1004, SOC 3004. (2H,2L,3C)

4644: HEALTH COUNSELING
Roles, responsibilities, legal requirements and scope of the health professional. Interviewing, counseling, education, health promotion and behavior change strategies for diverse populations. Guidance and referral, health assessment, communication skills, and problem-solving. Application of counseling techniques such as goal-setting, ethical practice, cultural competence, evidence-based practice. Pre: Junior Standing. (3H,3C)

4645-4646: APPLICATIONS IN NUTRITION COUNSELING
4645: Experiential methods to apply theories of behavior change to promote nutrition and health changes. Learn and apply nutrition care process using evidence-based knowledge through providing client-centered counseling to individuals. Understanding of contemporary issues related to behavior change and emerging issues through review of lay and professional literature. 4646: Advance nutrition counseling skills through work with more diverse clients. Learn and apply quality improvement skills to enhance nutrition counseling service. Identify information on emerging issues and apply appropriately in counseling setting. Pre: 4644 for 4645; 4645 for 4646. Co: 4125 for 4645. (2H,2C)

4754: ADVANCED HUMAN ANATOMY AND PATHOPHYSIOLOGY
Advanced laboratory course in human anatomy and physiology with an emphasis on how pathologic disease states affect human homeostasis. Congenital, genetic, chronic, and common global diseases with recognition and evaluation of causes, risk factors, and impact on body systems. Cadaver prosections will supplement models, specimens, and an advanced anatomy visualization system. Intended for students pursuing graduate education in health sciences. Pre: BMSP 2136, BMSP 2146. (2H,3L,3C)

4774: ADVANCED CONTEMPORARY TOPICS IN HNFE
A variable-content course. Explores advanced topics in the areas of nutrition, foods, exercise or health using higher- order thinking and problem-solving skills. Qualitatively and quantitatively assess current facts supported by scientific literature, as well as controversial issues with conflicting data. May be repeated for a maximum of six credits. Junior Standing. Variable credit course. Pre: 2014 or 2014H.

4834: APPLICATIONS IN CLINICAL EXERCISE
Supervised experience with the Therapeutic Exercise and Community Health Center. Direct Involvement with rehabilitative and preventive exercise and lifestyle programming for cardio-vascular, musculo-skeletal, and other conditions. Exercise leadership, case management, and daily operations. Included seminars, lab experience, and individual meetings with participants and supervisors, related projects. X-grade allowed. Pre: 3874. (9L,3C)

4844: EXERCISE AND NEUROMUSCULAR PERFORMANCE
Functional properties of the neuromuscular system. Emphasis placed on the acute and chronic responses of muscle in exercise, rehabilitation and the factors which determine human performance. Special emphasis on the molecular biological factors responsible for skeletal muscle development and differentiation, as well as adaptation to training and disease states, including activation of signal cascades responsible for the changes in muscle performance. Pre: 3804. (3H,3C)

4854: INTERNSHIP IN EXERCISE SCIENCE AND HEALTH PROMOTION
Capstone internship experience in the fields of exercise science and/or health promotion. The student will be immersed in the day-to-day challenges and responsibilities of a practicing health-fitness professional. The 45 contact hours per credit will involve work experience in some aspect of exercise science and/or health promotion. Senior standing and Exercise and Health Promotion majors only. May be repeated for maximum 3 credits. Pass/Fail only. Variable credit course. Pre: 4834.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Horticulture

Head: J. Roger Harris
Professors: E. Beers, R. Harris, J. Latimer, A. Niemiera, R. Veilleux, G. Welbaum, and T. Wolf
Associate Professors: S. Clark, S. Day, R. McDuffie, H. Scoggins, M. Williams, and B. Zhao
Assistant Professors: R. Arancibia, A. Bombarely Gomez, M. O'Rourke, J. Owen, and J. Samtani
Adjunct Professors: J. Atland, M. Chaungsheng, K. Da, Y. Dan, B. Flinn, Z. Liu, S. Lowman, and S. Zhang
Instructor: A. Hessler, B. Leshyn, and L. Taylor
A P Faculty Professional: D. Close, J. Freeborn, S. Gugercin, S. Huckestein, L. Fox, A. Straw, and A. Vallotton
Undergrad Program Director: A. Niemiera
Undergrad Program Coordinator: M. Wood

Web: **www.hort.vt.edu**

Overview

Horticulture is plant science that includes the study of plant growth and plant interactions with the environment (soil, air, water) to improve human life through the cultivation of crops and the maintenance of a sustainable environment. **Horticulture is unique as a scientific field of study in that it often**

utilizes artistic expression to aid the design of human landscapes and to restore natural environments. At its core it is an environmental science that recognizes that humans are dependent on their environment for sustenance and well-being that has developed as a field of study that recognizes humans are philosophically and artistically linked to nature through millions of years of human evolution.

Virginia Tech's Department of Horticulture offers graduate and undergraduate degrees in a range of applied and basic environmental plant science topics, from plant-soil interactions, biotechnology, landscape design, sustainable urban landscaping, urban forestry, crop production, and plant breeding. Our department is committed to engaging students in service and learning projects in the local community. To read more about our Engaged Department Award, **http://www.hort.vt.edu/newsCSECP.html**.

Landscape Contracting Major

Students learn to design, build, and manage beautiful and functional landscapes using science-based practices that improve the living environment and contribute to environmental sustainability.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Environmental Horticulture Major

Experience the creativity and rewards of the many facets of horticulture. Students can specialize in producing floriculture and nursery plants, growing sustainable fruits and vegetables, landscape design and management, and other areas of plant science.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

By the end of the academic year in which the student has attempted 72 hours (including transfer, advanced placement, advanced standing and credit by exam), "satisfactory progress" toward the B.S.

degree will include the following minimum criteria:

- having a grade point average of 2.0, overall and in-major
- passing at least 24 semester credits that apply to the Curriculum for Liberal Education
- passing the following:
    - MATH 1014 and 1025
    - CHEM 1035 and 1036
    - HORT 2224, 2234 or 2244
    - 6 credits additional HORT courses
    - 6 credits from CSES 3114 or 3134, ENT 4254, PPWS 4104

Undergraduate Course Descriptions (HORT)

2134 (FREC 2134): PLANTS AND GREENSPACES IN URBAN COMMUNITIES
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales. (3H,3C)

2144: INDOOR PLANTS
Basic horticultural principles, identification and cultural criteria applicable to foliage and flowering plants grown indoors. Specific plant groups discussed include ferns, cacti and succulents, and carnivorous plants, among many others. Non-majors only. (3H,3C)

2154 (SPAN 2154): SPANISH FOR THE GREEN INDUSTRY
Dialogue-based language course focusing on the vocabulary and grammatical structures pertaining to Green and Agricultural Industry jobs. Includes vocabulary and context specific to jobs and workers in greenhouse, nursery, turf and landscape environments. Spanish culture is included throughout the course along with grammar and structure. Prior study in Spanish is helpful but not required. I, II. (3H,3C)

2164: FLORAL DESIGN
Principles and methods in floral art through designs for home and public environments. (2H,3L,3C)

2184: PLANTS, PLACES, AND CULTURES IN A GLOBAL CONTEXT
Impact of worldwide production and trade in fruits, vegetables, and cut flowers (horticultural commodities) on societies, cultures, economies, politics, and environment. Case studies covering history, economics, social/cultural impacts of producing fruit, vegetables, tea, coffee, and other horticultural crops in producing and consuming countries. Case studies illustrate inextricable interactions and interconnectedness between horticultural crops and cultures. (3H,3C)

2224: HORTICULTURE SCIENCE AND INDUSTRY
Survey course of horticultural crops (fruits, vegetables, ornamentals) and enterprises. Includes plant science and business aspects of horticultural production and service industries, and introduces related issues and emerging technologies such as work force characteristics, organic production, and biotechnology. I. (2H,2C)

2234: ENVIRONMENTAL FACTORS IN HORTICULTURE
Principles and practices in managing environmental factors - temperature, water, light, atmospheric gases and pollutants, and soil and minerals - that influence growth and production of horticultural plants. (3H,3C)

2244: PLANT PROPAGATION
Principles and practices of plant propagation by sexual and asexual methods. (2H,2L,3C)

2304 (BIOL 2304): PLANT BIOLOGY
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of

plants. Pre: BIOL 1105, BIOL 1106. (3H,3C)

2554: ARBORICULTURE FIELD SKILLS
Field observation, discussion, and practice of skills employed in the management of urban landscape trees. Hands-on experience with tree pruning, removal, pest control, fertilization, cabling/bracing, lightning protection, and climbing. Emphasis on arborist safety, professional ethics, and best management practices. Guest instruction provided in part by professionals working in the tree care industry. Pass/Fail only. (3L,1C)

2834: SUSTAINABLE AGRICULTURE PRACTICUM
Hands-on training in sustainable agricultural production at a student-operated vegetable and fruit farm. Participation in tasks required in managing a diversified sustainable horticulture operation, including planting, pest management, irrigation, and post-harvest handling. Discussion of soil fertility, planning, efficiency, food safety and community food systems. May be repeated with different content, for a maximum of 6 credits. (1H,6L,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3114 (FST 3114): WINES AND VINES
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age. (3H,3C)

3325-3326: WOODY LANDSCAPE PLANTS
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants. (2H,3L,3C)

3345,3346: HERBACEOUS LANDSCAPE PLANTS
Identification, growing requirements, culture, landscape use, flowering and dormancy physiology, and unique propagation of native and non-native herbaceous plants for temperate environments. 3345: Summer and fall-flowering ornamental annuals and perennials; cultivated wildflower, wetland, and aquatic systems. 3346: Winter and spring-flowering species and related herbaceous foliage plants. Junior standing required. Pre: 2244. (1H,3L,2C)

3354 (FREC 3354): URBAN FORESTRY AND ARBORICULTURE
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment. Pre: (FOR 2314 or FREC 2314 or BIOL 2304 or HORT 2304), (FOR 2324 or FREC 2324 or HOR T 3325 or HORT 3326). (3H,3C)

3444 (CSES 3444): WORLD CROPS AND SYSTEMS
An introduction to world crops, their primary regions of production, the factors that determine where they are grown, and their economic importance, and how they are used in the human diet. Describes the various factors that can be managed to improve crop yields. Examines present and potential systems of farming for improved crop production in the major climatic and soil ecosystems of the world. Provides an opportunity to taste foods made in traditional and non-traditional ways from the crops hence from field to fork. Junior standing required. (2H,3L,3C)

3454: HERBACEOUS PLANTS FOR ECOLOGICAL LANDSCAPES

Plant selection to provide ecosystem services. Site analysis, design, preparation, planting and maintenance strategies specific to cold-hardy herbaceous plants including native and non-native perennials, and ornamental grasses. Philosophy, historical perspective, and case studies of ecological planting designs. Pre: 2234 or BIOL 1105. (3H,3C)

3544: LANDSCAPE CONSTRUCTION
Survey of landscape construction materials and methods. Concentration on small scale and residential applications, innovative uses, and cost estimates. (1H,3L,2C)

3584: LANDSCAPE CONTRACTING PRACTICUM
The development of practical skills in landscape contracting. The course will rotate between design and installation of water gardens, landscape irrigation systems, landscape lighting or other pertinent topics on consecutive years. The course can be repeated for exposure to specific subjects to maximum of 3 credits. Junior standing required. Pass/Fail only. Pre: 2224, 2234. (3L,1C)

3664: HARDSCAPE MATERIALS AND INSTALLATION
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction methods, and business aspects required for hardscape construction. Pre: 2224. (6L,2C)

4004: HORTICULTURE SEMINAR
Assessment of fundamental horticultural skills developed through academics and employment. Includes career placement preparation and problem solving through research and production project design and implementation using a team approach. Junior standing required. (1H,1C)

4064: SOIL MICROBIOLOGY
Soil microbes as determinants of plant growth, sustainable agricultural systems, and global nutrient cycles. Environmental controls of soil microbes and relationship to soil decomposition. Soil as a micro-habitat. Application to soil management and plant growth, plant-microbe mutualisms, probiotics, biocontrol, composting, ecosystem restoration, and disease suppression. Pre: BIOL 1105, (CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134). (3H,3C)

4205,4206: PUBLIC GARDENS MAINTENANCE AND MANAGEMENT
4205: Principles and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/accessions curation and database management; personnel and financial management issues unique to public gardens. Pre: Junior standing required. (3L,1C)

4324: GREENHOUSE MANAGEMENT
For persons who intend to manage or advise those managing commercial or institutional greenhouses. Includes greenhouse construction, environmenal controls, disease/insect identification and management, control of plant growth, root-zone management, and marketing and management principles specific to greenhouse operations. Pre: Coursework or experience in plant growth and environmental management required. (3H,3C)

4504: LANDSCAPE CONTRACTING
Capstone course for students entering the landscape contracting industry. Includes contracts, site plan interpretation, cost estimation and bidding, project sequencing, business marketing, irrigation design, and current issues. Emphasis on real-world skills and problem solving. Pre: Senior Standing Required. Pre: 3264, 4004. (1H,3L,2C)

4545-4546: SMALL SCALE AND RESIDENTIAL LANDSCAPE DESIGN Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction. Pre: 3325, 3544 for 4545; 3325, 3544, 4545, 4545 for 4546.

(2H,6L,4C)

4554 (BSE 4554) (FREC 4554) (LAR 4554) (SPIA 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: 2134 or FREC 2134. (3H,3C)

4614: ORNAMENTAL PLANT PRODUCTION AND MARKETING
In-depth production and marketing of woody and herbaceous plants in wholesale nursery and floriculture/greenhouse and related retail outlets. Includes production laboratory. Pre: 2234, 2244, 4324, AAEC 2434. (2H,3L,3C)

4644: SMALL FRUIT PRODUCTION
Propagation, production, and marketing of small fruit crops for the mid-Atlantic region. Emphasis on sustainable practices, market sectors, and health and nutritional benefits. Blueberries, strawberries, brambles and other crops. Pre: 2234, 2244, AAEC 2434. (3H,3C)

4654: VITICULTURE
Overview of grapevine growth and development, factors affecting yield and grape quality, and regional industry. Vineyard financial considerations, site evaluation, varietal characteristics plus cultural practices of pruning, training, canopy management, fertilization and pest management. Pre: 2234. (3H,3C)

4744: PLANT ESTABLISHMENT AND ENVIRONMENTAL DESIGN
Plant establishment and environmental design process for sustainable landscapes emphasizing the relationship between design of human-constructed landscapes and ecosystems at larger scales. Site assessment, urban soils, site rehabilitation, plant response to disturbed environments, green infrastructure and other contemporary landscape forms. Plant selection, sourcing, and installation to achieve environmental design goals. Emphasis on hands-on, experiential learning to achieve sustainable landscapes. Pre: Senior Standing. Pre: 2134 or FREC 2134 or CSES 3134 or ENSC 3134 or CSES 3114 or ENSC 3114 or GEOS 3614 or LAR 1254. (2H,3L,3C)

4764: VEGETABLE CROPS
A comprehensive study of major and minor vegetable crops of Virginia, the U.S., and world in relation to production practices, crop development, nutritional value, and quality characteristics. Pre: 2234. (3H,3C)

4784: VEGETABLE SEED PRODUCTION
The study of production agriculture or reproductive biology. Seed production, handling, identification, conditioning, enhancement, packaging, storage, testing, federal standards, and biotechnology. Pre: 4764 or 2244 or equivalent experience in vegetable crops, plant propagation, or plant growth and development. Pre: 4764 or 2244. (2H,2C)

4794: MEDICINAL PLANTS AND HERBS
Comprehensive study of medicinal plants/herbs history, production, processing, lore and documented scientific benefits. Traditional plant medicinal practices of Native Americans, Chinese, Indians, European and African cultures will be contrasted with use of contemporary herbal products. Pre: BIOL 1005 or BIOL 1105. (3H,3C)

4835-4836: ORGANIC VEGETABLE PRODUCTION
Detailed practices in organic vegetable production. Issues in starting organic production, profitability, organic transition strategies and organic certification. Pre: 2254, ALS 3404 for 4835; 4835 for 4836. (2H,2C)

4845-4846: ORGANIC VEGETABLE PRODUCTION LABORATORY
Field experiences, demonstrations, and farm tours complementing 4835 and 4836 lectures. Co: 4835 for 4845; 4836 for 4846. (3L,1C)

4964: FIELD STUDY

Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Hospitality and Tourism Management

Head: Nancy Gard McGehee
Undergraduate Program Coordinator: Z. Xiang
Professors: M. A. Khan, N.G. McGehee, J.L. Nicolau-Gonzalbez, and R.R. Perdue
Associate Professors: V.P. Magnini, M. Singal, and Z. Xiang
Assistant Professors: H. Kang, E. Kim, and F. Zach
Visiting Assistant Professor: K. Lamoureux
Professor of Practice: T. Duetsch, S. Feigenbaum, and C. Fitch
Lecturers: H. Feiertag and J.E. Sexton
Adjunct Faculty: S. Foster

Web: **www.htm.pamplin.vt.edu**
E-mail: **htmdpt@vt.edu**

Overview

The undergraduate program in hospitality and tourism management prepares students for leadership positions in hospitality and tourism, one of the world's largest industries. The department, which is ranked as one of the best in the world, seeks to provide students with a balance of industry-focused educational opportunities with directed work experiences. All students will take courses in hospitality, finance, food and beverage operations, tourism management, lodging operations, revenue management, and events. Special emphasis is placed on developing analytical, decision-making, leadership and communications skills. The degree requires an industry field study experience.

The curriculum is flexible, allowing students to pursue specific areas of emphasis. Recommended areas include hospitality operations, global tourism experiences, restaurant and food management, meetings and events, and club and resort management. We also offer a dual degree program with Real Estate which prepares students for the field of asset management or hotel brokerage.

The department offers a variety of international programs and study abroad experiences to give students an enhanced understanding of cultural diversity, experience in international business methods, and practical understanding of hotel and restaurant management in other countries. Through industry scholarships and internal fundraising activities, students are able to attend state, regional, and national hospitality and tourism meetings.

The department is strongly committed to the placement of it undergraduate and graduate students. Industry partners participate in on-campus interview sessions. Industry representatives visit the department during fall and spring semesters to interview students for both permanent placement and internships. HTM conducts a career fair each spring semester for companies offering both career and internships opportunities. Major employers recruit HTM graduates at Virginia Tech, including Marriott, Hyatt, Walt Disney World, Hilton, Compass, Four Seasons, Ritz Carlton, B.F. Saul Hotel Division, Interstate Hotels, Crestline Hotels and Resorts, Cvent, Great American Restaurants, and Panera Bread Company. HTM consistently enjoys one of the top job placement rates on campus for its graduates.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for

graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Hospitality and Tourism Management.

Satisfactory progress requirements toward the B.S. in Business can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (HTM)

1414: INTRODUCTION TO HOSPITALITY AND TOURISM MANAGEMENT
Hospitality & Tourism industry segmentation, management structures and practices, the significance of service delivery, economic impact of tourism and career opportunities. Concepts examined through readings, case studies and industry gues speakers. (3H,3C)

2314 (MGT 2314): INTRODUCTION TO INTERNATIONAL BUSINESS
Fundamental concepts of international business. International business environment and how it affects decisions, the creation of competitive advantage in the multinational firm, and complexities of managing it. Why international businesses exist, drivers of international expansion, differences among countries in terms of political, legal, economic, technological and cultural dimensions, and the complexity of international business decisions. Causes and consequences of globalization, international trade, and analyzing the challenges of managing international business, with a focus on a number of industries, including hospitality and tourism. Operational, strategic, and ethical issues which are unique to multinational corporations. (3H,3C)

2434: HOSPITALITY SALES
A comprehensive study of the management of the sales function and its role in the overall financial performance of hospitality operations. (3H,3C)

2454: TRAVEL & TOURISM MANAGEMENT
Introduction to travel and tourism both domestically and abroad. Includes topics such as the history, sociology and psychology of tourism; the tourism system, including private industry, associations and governing bodies; measuring and predicting travel motivations, behavior, and demand; and management issues in a global context. Course concludes with an international travel research final project. (3H,3C)

2464: INTRODUCTION TO SERVICE
An overview of the service industry, history, current status, and future trends. Emphasizes the unique characteristics and operations of service organizations. (3H,3C)

2474: INTRODUCTION TO MEETINGS & CONVENTION MANAGEMENT
A study of the meetings and convention industry. Focus on the components and processes involved in developing and conducting meetings and conventions. (3H,3C)

2514: CATERING MANAGEMENT
Introduces students to various venues in which catering services can be offered, and presents an

overview of the functions, processes, and controls found in successful catering management and operations; emphasis is placed on the sales/marketing aspects of the business. (3H,3C)

2954: HOSPITALITY AND TOURISM STUDY ABROAD
This course provides students with an international hospitality and tourism management business experience. It is only offered as part of a program outside the United States. Students will learn from the structured educational experience developed by the faculty directing the study abroad program. This course can be taken twice for a maximum of six credit hours. Sophomore standing and a minimum GPA of 3.0 required. (3H,3C)

2964: FIELD STUDY
X-grade allowed. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3044: PRIVATE CLUB MANAGEMENT
Develop an understanding of the private club sector of the hospitality industry. Topic areas are divided into club fundamentals, revenue-generating operations within clubs and support functions/departments of club operations. Junior standing as well as background courses in basic financial management are suggested. (3H,3C)

3114: SPECIAL TOPICS IN HOSPITALITY AND TOURISM STUDIES
Variable content that addresses timely and complex issues of the hospitality and tourism industry from a variety of disciplines or intellectual domains. This course provides HTM students with knowledge that is not formally part of the curriculum. Students will learn from the structured learning experience and knowledge domain developed by the faculty offering the course. May be repeated up to five times, for a maximum of 15 credit hours with different content. Pre: 1414 or 2454 or 2464. (3H,3C)

3244: FRANCHISING SERVICE INDUSTRIES
Theory and practice of franchising as a form of business ownership and a vehicle for entrepreneurship. Contemporary issues related to franchising in different segments of the services industries including hospitality and tourism. Legal aspects, financial viability, ethical issues, and agency relationships in franchising. Franchise concept development, franchisor-franchisee relationship, franchise agreements, family business, minority franchising, and international franchising. Junior standing required. (3H,3C)

3414: FOOD PREPARATION, PURCHASING AND MANAGEMENT
Food and kitchen safety, hazard analysis, purchasing, recipe development, costing, and volume food preparation, in a commercial kitchen lab experience one day per week along with a two hour per week lecture. Additional fee required. Junior Standing. (2H,5L,4C)

3424: EVENT MANAGEMENT
Management of special events in the hospitality and tourism industry. Organizational functions necessary for designing a broad range of special events, using formal elements of design to deliver successful events through use of effectively designed floor plans, event flow and logistics, risk management and contingency planning as well as analyzing the factors that influence an event’s success. Examine ethical issues at play in the context of modern event planning and implementation. Study review processes, evaluation methods and techniques used in events management. Sophomore standing. (3H,3C)

3444: FINANCIAL MANAGEMENT AND COST CONTROL FOR HOSPITALITY ORGANIZATIONS
The application of accounting, finance, and cost control principles to hospitality industry organizations. The focus if this course is to provide future food service and lodging organization managers with the ability to handle the unique problems regarding financial analysis and cost control in this industry. Pre: ACIS 2116, ECON 2006. Co: FIN 3104. (3H,3C)

3454: TOURISM ANALYSIS

Different aspects of tourism, including origin and destination flow models, tourism destinations and their attractiveness, impacts of tourism, tourist profiles and destination decisions, demand/supply interaction, and barriers to travel are explored and analyzed. (3H,3C)

3484: SOCIO-CULTURAL IMPACTS OF TOURISM
A study of both historic and current impacts of tourism on family, community, culture, government, globalization, and the environment at the domestic and international levels. The course uses a sustainable tourism framework to examine the complex ways in which tourism both affects and is affected by modern society worldwide. Includes topics such as eco-tourism, volunteer tourism and space tourism. (3H,3C)

3524: LODGING MANAGEMENT
Organization, function, and management of lodging operations. Current issues and management challenges in the lodging industry. Applications of revenue management to lodging systems. Pre-requisite: Junior standing in the Pamplin College of Business. (3H,3C)

3954: HTM STUDY ABROAD
This course provides students with an international hospitality and tourism management business experience. Students will be required to apply their knowledge and skills from their Pamplin College of Business core courses within this course. Students will learn from the structured educational experience developed by the faculty directing the study abroad program. Pamplin College of Business majors must have been approved for upper division course- work. Variable credit course.

4354: INFORMATION TECHNOLOGY AND SOCIAL MEDIA IN HOSPITALITY AND TOURISM
Introduction to the strategic use of information technology (IT) in today's hospitality and tourism organizations. Includes the most current and widely used information systems in operation, management, and e-business in hospitality and tourism as well as identification, discussion and debate of the ethical issues associated with these systems. Study of social media as a marketing tool for hospitality and tourism businesses. Examine impacts of IT on organizations and the industry as a whole. Pre: Sophomore standing. (3H,3C)

4414: FOOD AND BEVERAGE MANAGEMENT
Reviews organizational structures, terminology, administration and management of food and beverage operations. Discusses branding, franchising and industry benchmarking. Focuses on functional aspects including facilities design, equipment layout, labor management, purchasing and inventory management, cash management and control. Understanding the balance of human capital with service and quality standards. Reviews menu development, pricing and marketing strategies. Discussions of current issues and challengies in the industry as well as basics of alcohol/beverage service to include "Training for Intervention Procedures" (TIPS) certification. X-grade allowed. Pre: 3414. (3H,3C)

4434: EVENT AND EXPERIENCE MANAGEMENT SENIOR WORKSHOP
Senior experiential learning workshop to integrate and apply ethics, knowledge, design, concepts and capacities from past coursework by engaging in real world professional events and experiences. Students will explore and understand the complexity of managing events and the impact on the human experience. Pre: Senior standing. (1H,6L,3C)

4444: WINERY TOURISM
The course focuses on the role of wine and wineries in tourism, wine marketing and management in the hospitality industry, and examines the components of a winery. Students must be 21 years of age due to the inclusion of wine tasting in the course. Additional fee required. (3H,3C)

4454: HOSPITALITY REVENUE MANAGEMENT
Examines lodging and foodservices Revenue Management (RM) issues. Customer-centric approach, explores RM from various traditional academic perspectives, including economics, pricing, forecasting, consumer behavior, accounting, finance, and human resources. Management-oriented, emphasizes practical aspects of decision-making. Applies theoretical concepts through class discussion, group projects and individual assignments. Pre: 3444. (3H,3C)

4464: HUMAN RESOURCES MANAGEMENT IN THE HOSPITALITY INDUSTRY
An overview of the concepts of human resources management as applied to the specific environments within the hospitality industry. Pre: MGT 3304. (3H,3C)

4484: INTERNATIONAL TOURISM
Survey of global travel and tourism issues, including trends and patterns of global tourism, flow models, constraints and obstacles to international travel, demand for travel and tourism, tourism supply distribution, destination competitiveness, tourist safety and security, international travel and tourism organizations, performance measures. Analysis of sustainable indicators in protected areas and world heritage sites, tourism statistics and trends. Pre: MKTG 3104 or MKTG 3104H. (3H,3C)

4514: HOSPITALITY MARKET DATA ANALYSIS
Extraction and analysis of industry data on a selected market for development and presentation of the Market Study in a worldwide competition among other universities. In conjunction with a leading hospitality industry data provider, students have an opportunity to extract and analyze current industry data. Expands teamwork and communication skills through written and oral delivery of the study. Impact Analysis study of a recent current event on hotels, related and non-related travel sectors. Pre: 3524, 3444, 4454. (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY IN HTM
X-grade allowed. Pre: (3414, 3524) or (3414, 3444) or (3254, 3444). (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Industrial Design

Chair: Akshay Sharma
Associate Professors: W. Green, V. Haley, and B. Kennedy
Professor of Practice: M. Sullivan
Assistant Professors: J. Hauptman and E. Morshedzadeh
Adjunct Professor: R. Reuter
Professor Emeritus: R. Kemnitzer and E. Dorsa

Web: **www.industrialdesign.arch.vt.edu/**

Overview

As described by the Industrial Designers Society of America, "Industrial Design (ID) is the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer.

Industrial designers develop these concepts and specifications through collection, analysis and synthesis of data guided by the special requirements of the users, client and manufacturer. They are trained to prepare clear and concise recommendations through drawings, models and verbal descriptions.

Industrial design services are often provided within the context of cooperative working relationships with other members of a development group. Typical groups include management, marketing, engineering and manufacturing specialists. The industrial designer expresses concepts that embody all relevant design criteria determined by the group.

The industrial designer's unique contribution places emphasis on those aspects of the product or system that relate most directly to human characteristics, needs and interests. This contribution requires specialized understanding of visual, tactile, safety and convenience criteria, with concern for the user. Education and experience in anticipating psychological, physiological and sociological factors that influence and are perceived by the user are essential industrial design resources."

The internationally recognized program at Virginia Tech, fully accredited by the National Association of Schools of Art and Design, prepares individuals to enter this dynamic field through a rigorous curriculum and an experienced, dedicated faculty.

Program Requirements

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor in Industrial Design

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for minor requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Industrial Design.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (IDS)

2015-2016: INDUSTRIAL DESIGN LABORATORY II
Introduction to the discipline of Industrial Design. Emphasis on form generation, including: design theory, problem solving methodologies, conceptualization of ideas, and aesthetic sensibility. Secondary emphasis on skill development in 2 and 3 dimensions: awareness of materials and manufacturing processes, storyboarding, model making, written documentation of design process, and verbal presentation. IDS 2015 is taught in conjunction with IDS 3224: Topics in Design Competencies: Workshop and IDS 2065: Visual Design. Pre: ARCH 1016 for 2015; 2015 for 2016. 2015: (3H,7L,5C) 2016: (3H,9L,6C)

2044: HUMAN FACTORS
This course examines human factors as it informs the design process, and as a tool to maximize the physical and psychological aspects of design toward the establishment of a human centered design. Frameworks of industrial design philosophy, research methods, standards and data, human issues, cultural context, and design outcomes. Pre: ARCH 1016. (3H,3C)

2065-2066: DESIGN VISUALIZATION
An introduction to two-dimensional modes of representation. Emphasis is placed on the development of drawing skills to facilitate documentation, analysis and presentation in the design process. Pre: ARCH 1016 for 2065; 2065 for 2066. (2H,2C)

2114: HISTORY AND THEORY OF INDUSTRIAL DESIGN
The aesthetics and useful function of objects of industrial production. This class is based upon the concept that the values, ideals, and aspirations of a culture are expressed in material objects and a thorough knowledge of the history of the profession is essential to understand one's own particular circumstance and time. (3H,3C)

2124: HISTORY AND THEORY OF INDUSTRIAL DESIGN-DESIGNERS
The study of individual designers and how their values, ideals, and aspirations influence the evolution of design. (3H,3C)

2214: IDS STUDIO FOR MINORS
Introduction to the discipline and the critical elements that contribute to the complexity of a work of design. Emphasis on intellectual discipline, skills development, communication of ideas, materials research, and a self-motivated search for critical issues. For registered Industrial Design Minors only. (3H,9L,6C)

2304: COMPUTER AIDED INDUSTRIAL DESIGN
An introduction to computer aided two and three- dimensional design and modeling as applied in industrial design using both solid and surface software modeling techniques. Pre: ARCH 1016. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3015-3016: INDUSTRIAL DESIGN LABORATORY III
Introduction to systematic processes in design. Introduction and application of Human Factors and systematic planning methods in the development of industrial products in the areas of work, education and health. Development of professional presentation skills and methods. Pre: 2016 for 3015; 3015 for 3016. (3H,9L,6C)

3124: MATERIALS AND PROCESSES
Current design processes, materials, manufacturing processes, techniques, and equipment used in the design of products for mass and rapid production. Variety of materials and manufacturing processes available to the industrial designer for mass production impact his/her design process. Emphasis placed on the relationship of processes and equipment, to the environment and the end user. Includes concepts of material science. Practical issues of material selection and application, process selection, and specification. (3H,3C)

3204: TOPICS IN PROFESSIONAL DEVELOPMENT
Issues of practicing in an industrial design professional environment: public speaking, portfolio presentation, client/civic engagement (service learning), interdisciplinary teamwork and leadership in the development process of industrial products. Repeatable with instructor permission. Variable credit and duration. Variable credit course.

3214: IDS SUMMER STUDIO
Design Laboratory for industrial design. Introduction to systematic processes in design. Application of Human Factors and systematic planning methods in the development of industrial products in the areas of work, education and health. Development of professional presentation skills and methods. For industrial design majors only. Faculty permission required. (3H,9L,6C)

3224: TOPICS IN DESIGN COMPETENCIES

Issues of industrial design competencies and expertise required in a professional design environment, for example: software; model making (both hand making and digital rapid prototyping); workshop (wood, metal and plastics); specialized product design areas (packaging, furniture or exhibit design). Repeatable with instructor permission Variable credit and duration. Variable credit course.

3234: TOPICS IN DESIGN THEORY
Issues of industrial design theory required for advancement in a professional design environment, for example: Product Semantics; Design Ethics; EcoDesign/Sustainability; Universal Design. Repeatable with instructor permission. Variable credit and duration. Variable credit course.

3514: DESIGN RESEARCH
The course looks at the question of research and the ongoing exercise of re-definition for designers using examples of current design research corporations. Pre: 2016. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4015-4016: INDUSTRIAL DESIGN LABORATORY IV
Detailed analysis, research and application of human factors to the design of equipment, work spaces and environments. Design and construction of full scale, interactive models and spaces. Introduction to group activities. Emphasis on the needs, the production and marketing factors of special populations, such as the elderly and disabled. Pre: 3016 for 4015; 4015 for 4016. (3H,9L,6C)

4044: PROFESSIONAL PRACTICE AND ENTREPRENEURSHIP
Focus on assembling multidisciplinary teams to engage in the process of bringing a product to market, building a business around a core competency in design, the structure of a design office, and the development and protections of intellectual property. Pre-requisite: Senior standing or permission of instructor. Pre: 2015. (2H,2C)

4094 (ENGE 4094) (MGT 4094): STARTUP: COMMERCIALIZATION OF INNOVATION
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

International Studies

Director: Ioannis Stivachtis

Web: **www.liberalarts.vt.edu/academics/majors-and-minors/international-studies-major.html**

Overview

The International Studies Program offers four (4) majors, leading to a Bachelor of Arts in International Studies (BAIS):

- Major in International Public Policy (IPPL)
- Major in International Relations (IREL)
- Major in International Studies (IS)
- Major in National Security & Foreign Affairs (NSFA)

Students pursuing these majors are prepared to continue their studies in graduate or law school or immediately apply their skills and knowledge in various professional settings because of the broad applicability of both the theory to which they are exposed and the competencies they develop. Rooted in a strong liberal arts curriculum, the International Studies Program prepares students to enter careers in government service (Department of State, Department of Defense, Department of Homeland Security, the intelligence community), Foreign Service, Think Tanks, teaching, journalism, international governmental

and non-governmental organizations, and private companies.

Majors

Students may choose to pursue one or more of the four majors offered by the International Studies Program. In this case, no course can double count within or between International Studies-related majors with the exception of IS 1004, IS 2004, IS 2054, IS 2064, IS 2084, IS 3115, IS 3116 and IS 4004.

All students who wish to obtain a major offered by the International Studies Program must complete: 1) the Core Curriculum requirements of the College of Liberal Arts and Human Sciences; 2) the Core Curriculum requirements of the Bachelor of Arts in International Studies (BAIS) degree; and 3) a set of elective courses associated with each of the four majors.

The *International Public Policy (IPPL)* major is designed to help students analyze the choices and challenges that arise in the global economic system and equip them with a better understanding of how states and societies can pursue their economic goals in an environmentally and socially sustainable manner. It emphasizes the role of international organizations in global economy and development as well as helping students to think critically about the globalization's impact on world economy, sustainable development and the fight against global poverty. Its purpose is to relate theory to practice and provide students with a breadth of knowledge and training in the various facets of sustainable international development and the sub-fields of governance and political economy, environment and development, and international public health. It seeks to prepare students for a fast-growing number and variety of careers in the planning, implementation, and evaluation of development programs, working for governments, international organizations, NGOs, and private companies.

The *International Relations (IREL)* major focuses on the analysis of the political, societal, cultural, ethical, and normative aspects of international relations, as well as offering students a rigorous international and comparative perspective on the contemporary global system. It emphasizes a solid grounding in the methods of analysis used in the social sciences and humanities to help students think critically about international phenomena and analyze the choices and challenges that arise in this arena. It seeks to foster creative thinking about complex global problems and produce very competitive graduates and enlightened citizens who would possess the necessary knowledge and skills that would allow them not only to successfully pursue careers in their chosen field but, most importantly, serve their communities and the nation.

The *International Studies (IS)* major offers an opportunity to learn about foreign cultures, religions, languages, economics, and history. The curriculum is interdisciplinary in orientation and is designed to introduce students to a variety of important approaches for understanding the international scene. Whether or not students will pursue careers directly related to world affairs, the understanding gained in this major will provide a much broader perspective of the world and the United States' place in it. This major makes use of courses in economics, geography, foreign languages, history, religion and culture, sociology, and other disciplines.

The *National Security and Foreign Affairs (NSFA)* major offers students expertise and understanding of the broad range of threats to national and global security in the 21st century and equips them with the necessary knowledge and skills that would allow them to successfully pursue careers in diplomacy and international organizations. The National Security and Foreign Affairs (NSFA) major analyzes the role of diplomacy in the management of world affairs and examines in-depth U.S. grand strategy and foreign policy; the current and future global geopolitical environment that affect the U.S. and its interests; the ends, ways, and means that impact the use of military force; the informational issues that contribute to the holistic implementation of strategy, and counterterrorism and homeland security. It is designed to connect theory to practice thereby providing a hands-on, practical approach to the field that would equip students with the tools to analyze threats that challenge U.S. security both at home and abroad.

Please see **http://liberalarts.vt.edu/academics/majors-and-minors/international-studies-major.html** for more information.

Major Requirements

The curriculum is designed to provide foundational and development courses, major-specific study, and a capstone experience. Students are introduced to concepts early in the undergraduate career, and the curriculum allows them to build knowledge and skills as they work on increasingly complex tasks. They also develop skills in written, spoken, and visual communication across their studies in the major. At the foundational level, students in every major are required to take the same introductory courses. Then students move into one of four majors, and later they come back together in the senior year to work on a capstone experience.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor Requirements

The International Studies Program offers five (5) minors:

- Minor in Global Engagement (GLBE)
- Minor in International Public Policy (IPPL)
- Minor in International Relations (IREL)
- Minor in International Studies (IS)
- Minor in National Security & Foreign Affairs (NSFA)

For the 18-hour minor, students enroll in three required courses and choose other three courses from the minor elective list. Please see **http://liberalarts.vt.edu/academics/majors-and-minors/international-studies-major.html** for details.

The minor in *Global Engagement (GLBE)* offers a "hands on" – "minds on" approach to the understanding of global affairs. Adopting an experiential learning approach, this minor seeks to encourage and reward Virginia Tech students who wish to explore and study the "international" through a variety of educational tools, such as study abroad, in-class simulations, participation in various international organizations models (e.s., Model UN, Model NATO, Model OAS), field studies, undergraduate research, internships and externships, and educational programs and engagement opportunities offered by U.S. national federal agencies and other organizations, such as the Department of State (e.s., Diplomacy Lab and Foreign Policy Classroom), the Council of Foreign Relations, and the U.S. Institute for Peace.

The minor in *International Public Policy (IPPL)* is designed for students who wish to develop the analytical and leadership skills necessary to formulate and advocate policy on key international issues. It seeks to provide students with a detailed and systematic understanding of how political institutions, processes, and public policies operate in world affairs. The program brings together the academic study of international relations with analysis of public policy formulation and governance beyond the nation-state. The program seeks to prepare students for a fast-growing number and variety of careers in the planning, implementation, and evaluation of development programs, working for governments, international organizations, NGOs, and private companies.

The minor in *International Relations (IREL)* is designed to offer students a rigorous international and comparative perspective on the contemporary global system. It focuses on the changing political and cultural relations within the international system in the modern era, exploring how global, regional, and domestic factors influence relations between actors on the world stage. Students are equipped with both the foundational skills and specific knowledge necessary to analyze the choices and challenges that arise in this arena. The program seeks to provide a hands-on, practical approach to the field that would equip students with the analytic tools, language expertise, and cross-cultural understanding necessary to pursue successful careers in government, Foreign Service, and international organizations.

The minor in *International Studies (IS)* offers students an interdisciplinary approach to the study of global affairs. The purpose of the program is threefold: first, to supplement the knowledge and skills that students have acquired through their major field of study with knowledge about the global political and economic system and the global forces and processes that shape our daily lives; second, to further students' critical and analytical skills; and third, to create knowledgeable and enlightened citizens and global leaders.

The minor in *National Security and Foreign Affairs (NSFA)* analyzes the role of diplomacy in the management of world affairs and provides a hands-on, practical approach to security analysis that would equip students with the tools to analyze threats that challenge US security both at home and abroad. The program seeks to supplement the knowledge and skills that students have acquired through their major field of study with expertise and understanding of the broad range of threats to national and global security in the 21st century, as well as to equip students with the necessary knowledge and skills that would allow them to successfully pursue careers in diplomacy and international organizations.

Satisfactory Progress Toward the Degree

University policy requires that students demonstrate their progress toward the degree by meeting minimum requirements.

To proceed satisfactorily toward a degree, a student must complete IS 1004, IS 1034, IS 2004, IS 2054, IS 2064, IS 2084 and Foreign language 2105 & 2106 by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in-major GPA of 2.0.

Students who fall below the standard for either the overall GPA or the in-major GPA will have one semester to regain the required GPA standards. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in the major.

Undergraduate Course Descriptions (IS)

1004 (PSCI 1004): NATIONS AND NATIONALITIES
Introduction to world and American ethnic and indigenous cultures and to social constructions of human and group identity, nationalism and extreme ethno-nationalism. History of the political, economic, and cultural transition from primordial communities to sovereign states. Introduction to the rise of racism, sexism, ethnicism, classism, nativism, xenophobia, etc. in modern societies and episodes of mass political violence including ethnic cleansing and genocide. (3H,3C)

1024 (PSCI 1024): COMP GOV & POLITICS
Government and politics of selected countries outside the United States; nature of politics and government, types of political systems, linkages of people and governments, and current political issues. (3H,3C)

1034 (PSCI 1034): INTRODUCTION TO INTERNATIONAL STUDIES AND POLITICAL SCIENCE
Introduces students to the fields of International Studies and Political Science and their respective subfields. Familiarizes students with the undergraduate programs in International Studies and Political Science and emphasizes student preparation for careers in the respective fields. Focuses on inquiry, problem-solving, integration of ideas and experiences with a focus on International Studies and Political Science. Familiarizes students with the basic principles of the research and writing process. (3H,3C)

2004: RESEARCH AND WRITING IN INTERNATIONAL STUDIES
Introduces the research and writing process in the field of International Studies. Addresses topics such as selecting and planning a research project, conceptualizing a research design, gathering and analyzing data, interpreting the results and writing a report. (3H,3C)

2034 (GEOG 2034) (PSCI 2034): GEOGRAPHY OF GLOBAL CONFLICT
Geographical dimensions of global conflicts, international 'management' of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes. (3H,3C)

2044 (FST 2044) (PSCI 2044): FOOD, WAR AND CONFLICT
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict. (3H,3C)

2054 (GEOG 2054) (PSCI 2054): INTRODUCTION TO WORLD POLITICS
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues. (3H,3C)

2064 (GEOG 2064) (PSCI 2064): THE GLOBAL ECONOMY AND WORLD POLITICS
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies. (3H,3C)

2084 (PSCI 2084): THEORETICAL APPROACHES TO GLOBAL ORDER
Examines the evolution of the inter-state system and focuses on the political, economic, societal and technological progresses that shape the relations among states and people. Investigates topics such as the role of religion, culture and civilizations in world affairs; the globalization of the European system and the question of human equality; the impact of colonialism and post- colonialism on the question of justice and rights; and the effects of imperialism, capitalism and globalization on world order. (3H,3C)

2134 (GEOG 2134) (PSCI 2134): GEOGRAPHY OF THE GLOBAL ECONOMY
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century. (3H,3C)

2474 (RLCL 2474): RELIGION AND VIOLENCE
Investigation of the categories of religion and secularity as they apply to war and peace. Analysis of episodes from both past and present in which religion seems to have played a role. Introduction to research skills related to the study of religion and violence, building from theoretical and historical considerations. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004 (PSCI 3004): PROFESSIONALISM AND CAREERS IN POLITICAL SCIENCE AND INTERNATIONAL STUDIES
Designed to teach students how to synthesize skills and information learned in their Political Science and International Studies classes. Exploration of various career options, graduate school options, and proper procedures for seeking and applying for employment and graduate school. Introduction to professionalism in the workplace and professional development in the area of political science and international studies. Junior Standing. (3H,3C)

3034 (GEOG 3034) (PSCI 3034): THE CIA: ITS CAPABILITIES IN TODAY'S GEO-POLITICAL WORLD
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIA's operations in different regions of the world. (3H,3C)

3044 (PSCI 3044): THE POLITICS OF INTERNET GOVERNANCE
Introduces students to theoretical, technological, and policy debates in Internet governance. Topics include multistakeholder governance, cybersecurity and cybercrime, network investigative techniques, data protection, vulnerability disclosure, use of anonymity-granting technologies, network neutrality, virtual currencies, big data, algorithmic bias and decision-making, politics of the domain name system, privacy, free expression, cross-border dispute resolution, data ownership, and challenges to state authority. Pre: PSCI 2054 or IS 2054 or GEOG 2054. (3H,3C)

3054 (PSCI 3054): THE DARK WEB AND THREAT ANALYTICS
Introduction to dual-use anonymity-granting technologies such as the Dark Web. Covers open source threat intelligence as a technique to assess trends and trajectories in anonymous online content. Substantive topics include the use of Dark Web technologies for political expression in repressive regimes, anonymity and privacy protection in an age of big data as well as the misuse of these tools for doxing, trolling, and the creation of illegal markets for drugs, guns, malicious software, human trafficking, and child abuse imagery. Junior Standing. (3H,3C)

3104 (PSCI 3104): SECURITY STUDIES: THEORIES AND CONCEPTS
Introduces the various theoretical approaches to security. Examines key concepts in the field of Security Studies, such as uncertainty, polarity, war, coercion, terrorism, intelligence, genocide, crimes against humanity, ethnic conflict, and human security. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3114 (PSCI 3114): GLOBAL SECURITY
Explores various theoretical approaches to security and discusses traditional and non-traditional security issues. Focuses on global, international and regional security challenges and examines alternative strategic and tactical solutions for addressing them. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3115,3116 (PSCI 3115, 3116): SELECTED WORLD PROBLEMS
Selected world problems and how they affect various countries. Each semester, a topic will be chosen. (3H,3C)

3125-3126 (PSCI 3125-3126): INTELLIGENCE AND NATIONAL SECURITY
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process. Pre: 2054 or PSCI 2054 or GEOG 2054 for 3125; 3125 or PSCI 3125 for 3126. (3H,3C)

3134 (PSCI 3134): GLOBAL CONFLICT AND WAR
Focuses on the causes, legal and moral constraints, impacts, and consequences of conflict and war. Explores historical and contemporary cases of conflict and war and investigates the role of state and non-state actors in these conflicts. Examines the impact of technology, religion, culture and identity on the

present and future of war. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3135-3136 (PSCI 3135-3136): STRATEGIES OF MODERN WARFARE
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism. Pre: 2054 or PSCI 2054 or GEOG 2054 for 3135; 3135 or PSCI 3135 for 3136. (3H,3C)

3144 (PSCI 3144): GLOBAL GOVERNANCE & PUBLIC POLICY
Examines the norms, institutions, practices and processes developed by the international community to address global problems such as poverty, pandemics, global warming, displaced persons and transnational crime. Utilizes theories of decision- and policy-making and investigates the role of states, international governmental and non- governmental organizations, coalitions and corporations in global public policy-making. Pre: (2054 or PSCI 2054 or GEOG 2054), (IS 2064 or PSCI 2064 or GEOG 2064). (3H,3C)

3154 (PSCI 3154): TOPICS IN GLOBAL PUBLIC POLICIES
Examines in depth selected global public policies pertaining to health, energy, environment, development, education, refugees or labor. May be repeated with different content for a maximum of nine (9) credits. Pre: (2054 or PSCI 2054 or GEOG 2054), (IS 2064 or PSCI 2064 or GEOG 2064). (3H,3C)

3165,3166 (PSCI 3165, 3166): GLOBAL ECONOMIC GOVERNANCE & POLICY
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance - Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations. Pre: 2064 or PSCI 2064 or GEOG 2064. (3H,3C)

3175,3176 (PSCI 3175, 3176): GLOBAL DEVELOPMENT
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world. Pre: (2054 or PSCI 2054 or GEOG 2054), (IS 2064 or PSCI 2064 or GEOG 2064). (3H,3C)

3184 (PSCI 3184): HUMAN SECURITY
Introduces the field of human security and examines the conceptual, theoretical, and methodological issues surrounding it. Identifies the relevant human security actors, explores the tools of human security, and discusses the application of human security. Investigates the implications of human security and discusses its future. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3194 (PSCI 3194): NUCLEAR STRATEGY & POLITICS
Examines the fundamentals of nuclear strategy and investigates the politics associated with the acquisition and proliferation of nuclear weapons. Focuses on nuclear doctrines and policies and explores international efforts associated with nuclear arms control and disarmament. Analyzes the nuclear postures of various nuclear states. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3615-3616 (PSCI 3615-3616): INTERNATIONAL RELATIONS
Structure and development of the modern international system, theories of international policies, international law; international organizations. Pre: 2054 or PSCI 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 for 3615; PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 for 3616. (3H,3C)

3624 (PSCI 3624): FOREIGN POLICY AND DIPLOMACY

Focuses on actors, issues, and processes pertaining to foreign policy formulation and implementation. Examines theoretical and historical perspectives on foreign policy analysis. Investigates the national security, foreign policy, and diplomacy nexus. Discusses type of diplomacy and diplomatic methods. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3625,3626 (PSCI 3625, 3626): US-RUSSIA FOREIGN POLICIES
3625: Formulation of American foreign policy; roles of the President; Congress; press; public; and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Lenninist ideology. Pre: PSCI 1024 or PSCI 1024H. (3H,3C)

3634 (PSCI 3634): HUMAN RIGHTS: GLOBAL ISSUES
Identification, articulation and clarification of the relationship between human rights and other contemporary international phenomena, issues, events, and processes that affect human rights. Detailed consideration of the diverse traditions and cultural interpretations of human rights. Pre: PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H or PSCI 2054 or IS 2054 or GEOG 2054. (3H,3C)

3704 (PSCI 3704): NATIONAL SECURITY STRATEGY
Focuses on the causes of war and the conditions of peace. Examines the logic, levels, and outcomes of strategy and investigates the impact of international law and politics on the use of force. Explores contemporary strategic theory and discusses current issues in grand strategy. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3734 (PSCI 3734): NATIONAL SECURITY
Post-1945 strategic problems, policies, and security commitments of major participants in international politics, especially the United States and Russia; effects of security policies on international and domestic political economies. Pre: PSCI 2054 or IS 2054 or GEOG 2054. (3H,3C)

3735-3736 (PSCI 3735-3736): NATIONAL SECURITY POLICIES
Investigates the purposes, contexts and processes of national security policymaking both in the United States and in other states around the world. 3735: Focuses on Homeland Security. 3736: Focuses on Defense Policy. Pre: 2054 or PSCI 2054 or GEOG 2054 for 3735; 3735 or PSCI 3735 for 3736. (3H,3C)

3794 (PSCI 3794): TERRORISM AND COUNTERTERRORISM
Examines approaches to the categorization and causes of terrorism and discusses national and regional understandings of terrorism. Explores official and popular understandings of terrorism over time and across regions and investigates how social actors legitimate their use of violence. Focuses on the development of useful counterterrorism policies and utilizes case studies in terrorism and counterterrorism to emphasize the link between theory and practice. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3864 (AFST 3864) (HIST 3864): DEVELOPMENT AND HUMANITARIANISM IN AFRICA
Examines the history of western development and humanitarian projects in Africa, considering western and African perspectives in the nineteenth and twentieth centuries. Discussion of slavery and abolition, the civilizing mission, modernization and development theory, the impact of humanitarian projects, and international volunteerism. Provides a foundation for students interested in international service learning or careers with NGOs or international aid agencies. No prior knowledge of African history required. (3H,3C)

3944: INTERNATIONAL ENROLLMENT
Participation in an approved study abroad program without direct supervision of the Va Tech faculty but with required enrollment in an approved program of study in a foreign university. (0C)

3944S: INTERNATIONAL ENROLL SPECIAL 3
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents three billable hours and no academic credit. (0C)

3944T: INTERNATIONAL ENROLL SPECIAL 4
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty

but with required enrollment in an approved program of study in an international university. Course represents four billable hours and no academic credit. (0C)

3954: STUDY ABROAD
Variable credit course.

4004: SEMINAR IN INTERNATIONAL STUDIES
Interdepartmental seminar to synthesize and articulate basic assumptions, theories, and methods of international studies. Senior standing in IS and instructor consent required. (3H,3C)

4014: INTERNATIONAL DEVELOPMENT
Utilizes development, gender, and social theory to examine the impact of aid programs on communities in the Third World. Analyzes such issues as the impact of development projects in agriculture, natural resources, and employment on the local people, the impact of aid on women; and the policies and administrative structures that direct the world of international development. (3H,3C)

4024 (PSCI 4024): SEMINAR IN DIPLOMACY AND SECURITY
In-depth analysis of selected topics in diplomacy, strategy, and national security including issues pertaining to international conflict and cooperation; dimensions of national power; objectives of national policy and implementation of national strategy; diplomatic negotiations; and conflict resolution. Senior Standing. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

4034 (PSCI 4034): TOPICS IN DIPLOMACY LAB
Examines the fundamentals of policy analysis and formulation and emphasizes research and writing on topics pertaining to diplomacy, security, and foreign policy. Focuses on policy analysis and evaluation and concentrates on policy design. Emphasizes preparation and presentation of policy reports. May be taken three times for credit with different policy topics. Pre: Junior Standing. (3H,3C)

4044 (COMM 4044): INTERNATIONAL COMMUNICATION
Comparative perspectives on global communication systems; problems with the flow of information; roles of international organizations; mass communication and national development; implications for conflict resolution; selected case studies. Senior standing required or instructor consent required. (3H,3C)

4054 (PSCI 4054): SEMINAR IN GLOBAL POLITICAL ECONOMY
Examines theoretical and historical approaches to global political economy and assesses their practical implications. Focuses on issue areas such as production, trade, money, finance and investment and analyzes their implications for the global economic and political order. Investigates issues pertaining to economies of development and in transition. Senior Standing. Pre: 2064 or PSCI 2064 or GEOG 2064. (3H,3C)

4064 (PSCI 4064): SEMINAR IN GLOBAL DEVELOPMENT
Examines how economic and political forces interact in the developing world, discusses the history of these interactions from the pre-colonial period to the present and explores how colonialism shaped the developing world's economic and political trajectories. Utilizes case studies, historical analysis and development economics to better understand the economic and political condition of countries in the developing world. Senior Standing. Pre: 2064 or PSCI 2064 or GEOG 2064. (3H,3C)

4074 (PSCI 4074): THE POLITICS OF CYBERSECURITY
Analyses the politics of cybercrime, cyberwar, and the challenges of producing effective cybersecurity. Topics include the economics of cybersecurity, the cross-border nature of global cybercrime, encryption and anonymity-granting technologies, targeting critical national infrastructure, network investigative techniques, cybersecurity measurement, politics of zero-day vulnerabilities, and the process of providing effective cybersecurity at the individual, organizational, subnational, and national levels. Pre: PSCI 3044 or IS 3044. (3H,3C)

4614 (PSCI 4614): SENIOR SEMINAR IN INTERNATIONAL RELATIONS
Selected topics in international relations, including objectives of national policy; dimensions and components of national power; comparative diplomacy; international conflict and cooperation; instruments of conflict resolution. Topics vary from semester to semester as announced. Must have senior standing

and any two of the prerequisites. Pre: PSCI 3615 or PSCI 3616 or PSCI 3625 or PSCI 3626 or PSCI 3734. (3H,3C)

4714 (PSCI 4714): SENIOR SEMINAR IN POLICY ANALYSIS
Theoretical, analytical, and methodological approaches used to assess government activities and public policy. Topics vary from semester to semester as announced. Must have senior standing. Pre: PSCI 3724, PSCI 3734. (3H,3C)

4734 (PSCI 4734): THEORIES AND PRACTICES OF INTERNATIONAL CONFLICT MANAGEMENT
Examines alternative perspectives on peace, security, and international intervention and their implications for policy. Focuses on the role of international organizations and other actors in conflict resolution and peace-building and explores issues pertaining to humanitarian intervention, human security, and state-building. Utilizes case studies in peacekeeping and peace building to highlight the link between theory and practice. Pre: PSCI 3616 or IS 3616. (3H,3C)

4735,4736 (PSCI 4735, 4736): MULTILATERAL DIPLOMACY WORKSHOP
Investigates the purpose, context, and process of multilateral diplomacy and focuses on the strategies and tactics associated with it. Examines format and products of multilateral conferences, decision-making processes, negotiations, mediation, delegation management, and conference management. Utlilizes case studies and simulations. 4735: focuses on multilateral diplomacy at the United Nations. 4736: focuses on multilateral diplomacy in the framework of regional international organizations. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

4744 (PSCI 4744): INTELLIGENCE ANALYSIS WORKSHOP
Examines the impact of historical experience and bureaucratic structures on intelligence analysis. Discusses the contents of the intelligence agenda and explores issues pertaining to intelligence analysis. Focuses on the intelligence process and offers a target-centric approach to intelligence analysis. Emphasizes and evaluates the use of structured analytic techniques in intelligence analysis. Pre: 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

4754: INTERNSHIP
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Industrial and Systems Engineering

Head and Professor: E.M. Van Aken
Associate Department Head and Undergraduate Program Director: J.P. Shewchuk
Assistant Head and Graduate Program Director: M.A. Nussbaum
Charles O. Gordon Professor: G. Don Taylor, Jr.
John Grado Professor: J.G. Casali
Hal G. Prillaman Professor: M.A. Nussbaum
Paul T. Norton Professor: S.C. Sarin
Ralph H. Bogle Professor: B.M. Kleiner
John Lawrence Professor: K.P. Triantis
Rolls-Royce Commonwealth Professor of Advanced Manufacturing: J.A. Camelio
Professors: J.A. Camelio, J.G. Casali, B.M. Kleiner, Z. Kong, M. Madigan, M.A. Nussbaum, S.C. Sarin, G. Don Taylor Jr., K.P. Triantis, K.L. Tsui, and E.M. Van Aken
Associate Professors: D.R. Bish, E.K. Bish, D. Dickerson, K.P. Ellis, J.L. Gabbard, N. Ghaffarzadegan, L.K. Harmon, P. Jeon, R. Jin, C. Klauer, J.P. Shewchuk, and M.R. Taaffe
Assistant Professors: M. Bansal, X. Chen, R. Hildebrand, N. Hosseinichimeh, B. Johnson, R. Kannan, A. L'Afflitto, N. Lau, A. Salado, D. Srinivasan, S. Tunc, W. Xie, and X. Yue
Collegiate Associate Professor: N. Cherbaka
Collegiate Assistant Professor: L. Savage
Faculty Affiliates: M. Perez
Adjunct Faculty:L. Franklin, J. Geraghty, J. Godfrey, G. Keller, K. Lee, and W. Vaneman
Professors Emeritus: B.S. Blanchard, M.P. Deisenroth, W.J. Fabrycky, P.T. Kemmerling, K.H. E. Kroemer, H.A. Kurstedt, D. L. Price, J.W. Schmidt Jr., H.D. Sherali, H.L. Snyder, W.G. Sullivan, W.W. Wierwille, and R.C. Williges
Associate Professors Emeritus: P. Ghare, P. Koelling, J.A. Nachlas, and R.E. Taylor
Academic Advisors: M. Johnson and P. Van Curen

Web: **www.ise.vt.edu**

Overview

The mission of the Grado Department of Industrial and Systems Engineering is to:

- Prepare undergraduate and graduate students for life-long success and leadership in the profession, in industry, and in higher education;
- Conduct and disseminate research that advances knowledge; and
- Serve the profession, industry, and society.

Industrial and systems engineering is one of the most diverse fields in engineering. ISE is concerned with the design, improvement, and installation of integrated work systems of people, materials, equipment and technology, processes, information, and capital. The industrial engineer is concerned with creating value and improving performance of integrated systems, whether that involves improving quality and productivity, reducing costs and non-value adding activities, improving customer satisfaction, or improving worker safety.

The applications for industrial engineering capabilities include industry, government, and service organizations. Graduates of the ISE program at Virginia Tech work in manufacturing facilities, distribution warehouses, hospitals, airlines, railroads, banks, amusement parks, the military, federal government, and management consulting firms. The boundaries of where IEs make contributions are limitless.

The mission of the ISE Undergraduate Program is to prepare industrial and systems engineering students to create value for organizations, the profession, and society. We achieve this mission by recruiting, retaining, and educating high quality and diverse students and by creating a rigorous and collegial environment enabling students to learn industrial engineering methods and tools, built upon a foundation of mathematical, physical, and engineering sciences, and to apply them in any global organizational setting. Students are able to achieve academic and professional success through opportunities to participate in various educational experiences, to develop capabilities as future leaders, and to embark on a lifelong journey of professional development and learning.

Program Educational Objectives and Student Outcomes

The ISE faculty, with input from our external Advisory Board, employers, and students, have defined the following Program Educational Objectives (PEOs) and Student Outcomes for our Undergraduate Program. PEOs are statements that describe the expected accomplishments of ISE graduates within 3-5 years after graduation. Student Outcomes are statements that describe what students are expected to know and be able to do at the time of graduation.

Program Educational Objectives: Within 3-5 years of graduation, ISE alumni will have:

- Created value by applying appropriate industrial and systems engineering tools to design/redesign integrated systems/processes, solve problems, implement innovative solutions, and improve organizational outcomes.
- Provided formal or informal project, administrative, or technical leadership.
- Pursued professional development and knowledge enhancement via graduate study and/or continuing education in industrial engineering or related areas.
- Communicated effectively with different audiences and stakeholders using written, oral, and visual media.
- Worked effectively in teams having attributes such as varying organizational backgrounds, positions, geographic locations, and demographic compositions.
- Served the profession, community, and society as exemplified in our motto *Ut Prosim*.

Student Outcomes: At the time of graduation, ISE students will have:

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(3) an ability to communicate effectively with a range of audiences
(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Industrial and Systems Engineering program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

Curriculum

The ISE curriculum explicitly encompasses coursework useful in addressing not only the technical elements of work systems, but also the organizational, economic, and human elements. Our aim is to provide graduates with the knowledge and capabilities to enable them to successfully pursue careers in industrial engineering or to continue on to graduate study.

ISE emphasizes instruction in fundamental engineering principles based on the physical sciences, engineering sciences, mathematics, and statistics. These principles are applied in practical design experiences throughout the undergraduate curriculum.

Course work in the physical and chemical sciences and mathematics provides a solid background for basic engineering science courses, which in turn support more focused courses in industrial engineering, covering topics in operations research, manufacturing systems engineering, human factors engineering and ergonomics, and management and systems engineering. In all these areas, analysis and design activities are supported by modern computing and software tools taught in the curriculum.

Students gain valuable hands-on experience in multiple areas of our curriculum in state-of-the-art laboratory facilities associated with the undergraduate program. These include the ISE Senior Design Center, with computer support and other resource material for student design projects; the Harris Manufacturing Processes Laboratories, which contain robotics and automation equipment, machining equipment, conventional and numerically controlled machine tools, and welding and foundry facilities; the Human Factors Work Measurement and Methods Engineering Laboratory, which is equipped and used for in-class exercises and experiments in work measurement, motion economy and time study, psychophysics, human audition and vision, and work station design. Students also have the opportunity to work on Undergraduate Research with faculty and graduate students in the many ISE research labs and groups.

The capstone course in the ISE Undergraduate Program is a two-semester class, ISE 4005-6 Project Management & System Design (also referred to as "Senior Design"), where students work in project teams with an external company sponsor to solve a real-world problem. This experience provides ISE students with actual project experience that develops technical and professional skills, such as teamwork, communication, project management, and life-long learning skills, in addition to developing capabilities in applying IE tools and techniques. Student project teams present their project findings at our annual Senior Design Symposium attended by company sponsors and the ISE Advisory Board.

For the 2020 graduation requirements, the course work totals 127 hours. Electives provide students with the opportunity to explore other areas of engineering, as well as cultural, societal and creative experiences, which makes for a well-rounded, diverse, and globally-aware engineer.

The ISE program also provides students with the opportunity to pursue minors, such as a Business Minor, Green Engineering Minor, or Statistics Minor. Specific information about minors available to ISE students can be found in the ISE Undergraduate Student Handbook, posted on the ISE web site. Students and employers alike are seeing the benefits of these minors for adding value to the ISE major.

Many ISE students seek to participate in Undergraduate Research to satisfy elective requirements in the curriculum. The opportunity to work more closely, in some cases on a one-on-one basis, with our outstanding faculty can provide more in-depth development of ISE capabilities and a more enriching educational experience.

The department participates in the Cooperative Education & Internship Program, in which qualified students may alternate semesters of study with semesters of professional co-op employment or internships. Students are encouraged to pursue these experiences before they graduate to make them more competitive in the work force. Students are also encouraged to participate in career fairs and job interviews on and off campus.

The ISE department also provides students with many significant scholarship opportunities at the undergraduate and graduate levels to encourage and acknowledge high academic performance and achievements. The ISE department also maintains bilateral student exchange agreements with international universities, where students can take ISE courses which will transfer back to their BSISE. Students may also select other universities at which to perform a study abroad semester.

Graduate programs leading to the M.S. and Ph.D. are offered (see Graduate Catalog). The graduate programs include concentrations in manufacturing systems engineering, human factors engineering and ergonomics, operations research, and management and systems engineering. The ISE Department also coordinates on- and off-campus master's degree programs in systems engineering (M.S.) and engineering administration (M.E.A.). The department also offers the accelerated undergraduate/graduate program for students interested in pursuing their Master's degree in ISE. More information is available on the ISE Department website.

Program Requirements

The graduation requirements in effect at the time of graduation apply. When choosing degree requirements information, students should always choose the year of expected date of graduation. Graduation requirements are referred to via university publications known as "checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **https://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Students are strongly encouraged to meet with one of the ISE Academic Advisors to discuss the BSISE curriculum.

Undergraduate Course Descriptions (ISE)

2004: INTRODUCTION TO INDUSTRIAL AND SYSTEMS ENGINEERING
Introduction to the industrial and systems engineering profession through exposure to problems, principles, and practice. Integrated systems approach to problem solving. Foundation of data manipulation and preparation for problem analysis. Development of communication skills, career opportunities, importance of professionalism, ethics, contemporary challenges, lifelong learning, and introduction to the ISE Department. (1H,3L,2C)

2014: ENGINEERING ECONOMY

Concepts and techniques of analysis for evaluating the value of products/services, projects, and systems in relation to their cost. Economic and cost concepts, calculating economic equivalence, comparison of alternatives, purchase versus lease decisions, financial risk evaluation, cash flow sensitivity analysis, and after-tax analysis. (2H,2C)

2034: DATA MANAGEMENT FOR INDUSTRIAL AND SYSTEMS ENGINEERS
Investigation of data modeling, storage, acquisition, and utilization in industrial and systems engineering via manual and computerized methods. Development of effective spreadsheet applications. Design and implementation of relational databases via entity-relationship modeling, relational schema, and normalization. Web-based database applications. Interface design and the system development life cycle applied to data management applications. All topics covered within the context of typical industrial and systems engineering problems. Pre: CS 1044 or CS 1064. (3H,3C)

2204: MANUFACTURING PROCESSES
Survey of manufacturing processes including casting, forming, machining, welding, joining, and non-traditional processes such as laser-beam and electrical-discharge machining. Basic structure of metals, physical, and mechanical properties and their relationship to manufacturing. Process planning and the effect of plans on cost, safety, and the environment. Impact of product design on manufacturability: design for manufacture, assembly, etc. Also include topics in inspection and testing, jigs and fixtures, and numerical control. C- or better required in ENGE 1104 or ENGE 1114 or ENGE 1434 or ENGE 1216. Pre: ENGE 1104 or ENGE 1114 or ENGE 1216 or ENGE 1414. (3H,3C)

2214: MANUFACTURING PROCESSES LABORATORY
Laboratory exercises and experimentation in manufacturing processes. Emphasis on using production machines and equipment to make products using multiple manufacturing processes, coupled with inspection per engineering drawings. Processes include assembly, casting, machining, forming, welding, and non-traditional machining, performed manually and/or via computer programming. Also covers basic shop floor operation and documents used for monitoring and controlling part production. (3L,1C)

2404: DETERMINISTIC OPERATIONS RESEARCH
I Deterministic operations research modeling concepts; linear programming modeling, assumptions, algorithms, modeling languages, and optimization software; duality and sensitivity analysis with economic interpretation; network models (formulations and algorithms), including transportation problems, assignment problems, shortest path problems, maximum flow problems, minimum cost network flow problems, minimal spanning tree problems. A C- or better required in MATH 1114 or MATH 2114. Pre: MATH 1114 or MATH 2114. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3004: INDUSTRIAL COST CONTROL
Fundamentals of general and cost accounting practices applied to manufacturing and service organizations. Cost accounting, standard cost determination, cost and budgetary control systems. C- or better required in ISE 2014. Pre: 2014 or ME 2024. (4H,3C)

3214: FACILITIES PLANNING AND LOGISTICS
Theory, concepts, and methods for designing and analyzing facilities and material flow in manufacturing, storage, and distribution environments. Topic areas include material handling systems, facility layout, facility location, warehousing, distribution, logistics, and transportation. C- or better in ISE 2014, 2404, and 3414. Pre: 2014, 2404. Co: 3414. (3H,3C)

3414: PROBABILISTIC OPERATIONS RESEARCH
This course introduces probability models used to investigate the behavior and performance of manufacturing and service systems under conditions of uncertainty. Major topics include probability, conditioning, elementary counting processes, and Markov chains and Markov processes. Emphasis is on the use of these tools to model queues, inventories, process behavior, and equipment reliability. C- or better required in STAT 4105,

MATH 2224 or 2204, MATH 2214 or 2214H, and ISE 2004. Pre: 2004, STAT 4105, (MATH 2204 or MATH 2204H or MATH 2406H), (MATH 2214 or MATH 2214H), (CS 1044 or CS 1064). (3H,3C)

3424: DISCRETE-EVENT COMPUTER SIMULATION
Analysis and design of work systems through static and dynamic simulation. Topics include an introduction to systems analysis and modeling, simulation optimization, model development and testing, and problem analysis through simulation. C- or better required in ISE 3414 and STAT 4105. Pre: 3414, STAT 4105. (2H,3L,3C)

3434: DETERMINISTIC OPERATIONS RESEARCH II
Advanced concepts in deterministic operations research, including theory of complexity, integer programming, advanced linear programming techniques, nonlinear programming, dynamic programming. Covers modeling languages and optimization software for integer programming and nonlinear programming problems. Grade of C- or better required in ISE 2004, 2404 and MATH 2204 or 2224. Pre: 2404, (MATH 2224 or MATH 2204), ISE 2004. (3H,3C)

3614: HUMAN FACTORS ENGINEERING AND ERGONOMICS
Investigation of human factors, ergonomics, and work measurement engineering, with emphasis on a systems approach toward workplace and machine design. Discussion of basic human factors research and design methods, design/evaluation methods for work systems and human machine interactions, human information processing, visual and auditory processes, display and control design, and effects of environmental stressors on humans. C- or better required in ISE 2004. Pre: 2004. Co: STAT 4105. (3H,3C)

3624: INDUSTRIAL ERGONOMICS
Introduction to ergonomics and work measurement with an emphasis on people at work. Discussion of methods for work measurement, ergonomic assessment, and evaluation, with major topics including productivity and performance, manual materials handling, work-related musculoskeletal disorders, safety, training and legal issues. C- or better required in ISE 3614. Pre: 3614, ESM 2104. (3H,3C)

4004: THEORY OF ORGANIZATION
A theory of cooperative behavior in formal organizations, including the structure and elements of formal organizations. The executive process and the nature of executive responsibility also are examined. (3H,3C)

4005-4006: PROJECT MANAGEMENT AND SYSTEMS DESIGN
4005: Capstone design experience for ISE majors. Structured systems engineering and project management methods and tools to plan, manage, and execute technical industrial and systems engineering projects. Students work in teams to apply industrial and systems engineering and project management tools to define and analyze a real-world problem. 4006: Continuation of capstone design experience for ISE majors. Designing, implementing, and evaluating work system solutions. Communication of solutions to various project stakeholders. C- or better in all prerequisites. Pre: 2034, 2214, 3214, 3424, 4404 for 4005; 4005, 3624, 4204 for 4006. Co: 3624 for 4005. 4005: (3H,3C) 4006: (2H,2C)

4015,4016: MANAGEMENT SYSTEMS THEORY, APPLICATIONS, AND DESIGN
Systems approach to management, domains of responsibility, structured and synergistic management tools, management system model, contextual frameworks, information portrayal, automation objectives model, evaluation, shared information processing, information modeling. A management process for definition, measurement, evaluation and control, the organization as an information processor, corporate culture, scoping agreements, schemas and management elements, structured design. (3H,3C)

4204: PRODUCTION PLANNING AND INVENTORY CONTROL
Planning and control of operations in both manufacturing and service industries. Effective management and utilization of resources and the production of cost effective products and services. Principles, models, and techniques used for production planning and inventory control. C- or better required in ISE 2404, ISE 3414, and STAT 4706. Pre: 2404, 3414, STAT 4706. (3H,3C)

4214: LEAN MANUFACTURING
Overview of Lean Manufacturing principles, theory, methods, and techniques in modern manufacturing enterprises. Lean philosophy and basic concepts, master production scheduling and production smoothing,

assembly line sequencing, setup time reduction, U-shaped line balancing/operation, machine arrangement, kanban, autonomation, and value stream mapping. Investigation and discussion of lean manufacturing case studies. C- or better required in ISE 4204. Pre: 4204. (3H,3C)

4264: INDUSTRIAL AUTOMATION
A survey of the various technologies employed in industrial automation. This includes an emphasis on industrial applications of robotics, machine vision, and programmable controllers, as well as an investigation into problems in the area of CAD/CAM integration. Examination of the components commonly employed in automation systems, their aggregation and related production process design. Laboratory work is required. C- or better required in ISE 2204 or ISE 2214. Pre: 2204 or 2214. (2H,3L,3C)

4304: GLOBAL ISSUES IN INDUSTRIAL MANAGEMENT
Industrial management topics of current interest explored from a global perspective. Current domestic and international challenges resulting from a global marketplace and the proliferation of information and technology. Industrial management and organizational performance, total quality management, business process re-engineering, leadership, organizational change, role of communication and information, and ethics. Examination and comparison across international boundaries. (3H,3C)

4404: STATISTICAL QUALITY CONTROL
Application of statistical methods and probability models to the monitoring and control of product quality. Techniques for acceptance sampling by variables and attributes are presented. Shewhart control charts for both classes of quality characteristics are examined in depth. The motivation for each method, its theoretical development, and its application are presented. The focus is upon developing an ability to design effective quality control procedures. C- or better required in ISE 3414, STAT 4105, and STAT 4706. Pre: 3414, STAT 4105, STAT 4706. (3H,3C)

4414: INDUSTRIAL QUALITY CONTROL
Implementation of statistical quality control techniques in an industrial setting. Development and analysis of cost models for use in the design of optimal quality control plans. Also included are new techniques, advanced quality control models, and an examination of the role of industrial statistics in the overall product quality assurance function. C- or better required in ISE 4404. Pre: 4404. (3H,3C)

4424: LOGISTICS ENGINEERING
Introduction to the key issues in the integrated support of a product or process. Synthesis of topics from earlier studies to provide a cohesive approach to their applications. Logistics engineering provides a survey of product support issues and methods of resolving them within the context of the overall production activity. C- or better required in ISE 3414. Pre: 3414. (3H,3C)

4434: SUPPLY CHAIN AND OPERATIONS ENGINEERING
Mathematical models, algorithms, and tools to support the design/redesign and management of supply chain systems. Resiliency, reliability, efficiency, and effectiveness of supply chains; collaboration and coordination among the different decision-makers in supply chains; impact of new developments on supply chain engineering, including the growth of the internet and e-commerce, the need to build suitable and environmentally-friendly supply chains. Mathematical modeling and system-wide optimization of the entire supply chain system under certainty. Pre: 2404, 3414. (3H,3C)

4624: WORK PHYSIOLOGY
Anthropometry, skeletal system, biomechanics, sensorimotor control, muscles, respiration, circulation, metabolism, climate. Ergonomic design of task, equipment, and environment. C- or better required in 3624. Pre: 3624. (3H,3C)

4644: OCCUPATIONAL SAFETY AND HAZARD CONTROL
Survey of occupational safety. Topics include: history of occupational safety; hazard sources related to humans, environment, and machines; engineering management of hazards. C- or better required in ISE 3614. Pre: 3614. (3H,3C)

4654: PRINCIPLES OF INDUSTRIAL HYGIENE
Introduction to the foundations of the field of Industrial Hygiene, that discipline devoted to the anticipation,

recognition, measurement, evaluation, and control of occupational health hazards. Includes biological (e.g. microbial agents, allergens), chemical (e.g. solvents, carcinogens, dusts), and physical (e.g. radiation , temperature) hazards. Overview of control of health hazards, such as personal protective equipment, administrative controls, and engineering controls. Will involve lecture and participatory "case-study" activities. Will provide ample opportunity for hands-on use of monitoring equipment, protective equipment and controls testing devices. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Interior Design

Chair: L. Tucker
Professors: L. Tucker[7,2]
Associate Professors: G. Tew[4,2] and B. Whitney
Assistant Professors: M. Wagner and E. Tural
Associate Professor Emeritus: B. Parsons

Web: **www.archdesign.vt.edu/interior-design/**

Overview

The interior design program at Virginia Tech is dedicated to improving quality of life through design excellence, professionalism, and public service. With a curriculum that equally respects the importance of creative skill, history, building technology, ethics, innovation, and business practice, our graduates have the ability and confidence needed to immediately contribute to the profession.

Students in the interior program begin their studies in the foundation design laboratory during the first two semesters with architecture, landscape architecture and industrial design students. From the beginning, both an independent and team approach to design solutions is encouraged.

In their professional studies students are challenged to think critically in their design of space and to develop solutions that not only enhance quality of life, but also protect the health, safety, and welfare of users as prescribed in the various codes and regulations that govern the work of interior designers. This philosophy is the core of our program. It establishes a foundation upon which each student graduates

with creative ingenuity and professional responsibility.

Our CIDA accredited program prepares future designers for licensure and practice. A degree from a CIDA accredited program is increasingly important as a requirement for professional certification and licensing of Interior Designers in the United States. Graduating from a CIDA accredited program is the first step in a three-part process in achieving certification or licensing as an interior designer in various states. The last two steps are to complete two years of assistantship as an interior designer and then passing the National Council for Interior Design Qualification (NCIDQ) examination. A CIDA accredited degree, work experience and passing the NCIDQ exam satisfy the requirements in Virginia for recognition as a "Certified Interior Designer."

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Urban Affairs and Planning.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (ITDS)

1114: DESIGN APPRECIATION
Introduction to fundamental design concepts, design methods and the history of design. Examples drawn from architecture, interior design, industrial design, graphic design as well as vernacular craft and design traditions. Key concepts from art, literature and philosophy are discussed in relation to design theory. (3H,3C)

1224: INTRODUCTION TO INTERIOR DESIGN
Introduction to the elements and principles of interior design, the discipline and practice of interior design. Case studies from interior design practice. Design thinking, language of design, career paths, contemporary issues, global issues, presentation and drawing techniques and sketchbook preparation. (3H,3C)

2044: INTERIOR DESIGN I
First in a series of six studios. Foundation level interior design studio. Exploration and development of interior spaces emphasizing spatial volume, human factors, elements and principles of design, and presentation techniques. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). Pre: ARCH 1016. (1H,11L,6C)

2054: INTERIOR DESIGN II

Spatial relationships continue as a priority from ITDS 2044 and become more advanced. Programs of required spaces are introduced in design projects along with issues of human behavior and perception and color. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). Pre: 2044. (1H,11L,6C)

2134: MATERIALS AND METHODS IN INTERIOR DESIGN
Properties and appropriate use of materials in design and construction of building interiors. Floor, wall, and ceiling materials, and materials used in furnishings and equipment are included. Special attention is given to the health effects and environmental impact of material choices in interior design. (3H,3C)

2224: INTERIOR DESIGN GRAPHIC COMMUNICATION
Exploration and development of advanced presentation techniques appropriate for communicating interior design concepts. Special attention is given to utilizing digital media as support for visual and verbal communication. Pre: 2114. Co: 2144. (6L,3C)

2984: SPECIAL STUDY
Variable credit course.

3044: INTERIOR DESIGN III
Exploration and development of interior spaces emphasizing corporate office use, branding of interior environments, and building system integration. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). Pre: 2054. (1H,11L,6C)

3054: INTERIOR DESIGN IV
Design process, space planning and code compliance with advanced understanding of appropriate concepts for integrating furniture, fixtures, equipment, color, and finish materials in design solutions. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). Pre: 3044. (1H,11L,6C)

3114: SUSTAINABLE DESIGN AND BIOPHILIA
Sustainable design concepts and theories. Ethical considerations of biophilia, biomimicry, cradle-to-cradle, and other emerging ways of addressing environmental sustainability. Use of biophilia to guide decision making in the built environment. Use of core green building concepts including water use, energy use, sustainable sites and materials. Review of Green Building standards. (3H,3C)

3125,3126: HISTORY OF INTERIORS
Survey of significant developments in the design of interiors, furniture, and materials culture with a focus on western civilization. Style, scale, material culture of each period. Social, economic, technological and political influences on design. Significant designers and craftsmen. 3125: 3000 BC through the 19th century European. Egypt, Greece, Rome, Renaissance, Baroque, Rococo, Neoclassical. 3126: Colonial America through 21st century including Modern design. Bauhaus, DeStijl, Post-War, Post-Modern, Eastern influences. (3H,3C)

3175-3176: BUILDING SYSTEMS FOR INTERIOR DESIGN
Overview of building systems as they relate to the design of building interiors. 3175: overview of building construction including structural systems and materials, code information and thermal concepts related to building systems. 3176: lighting for buildings, sustainable design guidelines, integration of building systems. Pre: 2044 for 3175; 2044, 3175 for 3176. (3H,3C)

3184: CONSTRUCTION DOCUMENTS FOR INTERIOR DESIGN
An overview of construction documents: drawings and specifications. Development of a set of construction documents for a small commercial interior. (3H,3C)

3954: STUDY ABROAD-INTERIOR DESIGN
Variable credit course.

4044: INTERIOR DESIGN V
High-level spatial quality and design solution. Exploration and development of interior spaces for a variety of project types. Focus on collaboration and team work. Course contact to credit hour structure: Lecture

(1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). Pre: 3054. (1H,11L,6C)

4054: INTERIOR DESIGN VI
Senior Thesis studio requiring the integration of research and the design of a self-generated project. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C). Pre: 4044, 4994. (1H,11L,6C)

4224: DESIGN RESEARCH FOR INTERIORS
Project Programming and Design Research Methods in Interior Design. Evaluate and apply design research. Methods in design research, evidence-based design, and neuroscience. Co: 4044. (3H,3C)

4554: CONTEMPORARY INTERIOR DESIGN PRACTICE
Study of social, economic, political, and technological issues that influence contemporary interior design practice. Pre: 3126. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Landscape Architecture

Program Chair: Terry Clements
Professors: T. Clements and P. Miller
Associate Professors: D. Bork, N. Heavers, W. Jacobson, B. Katen, P. Kelsch, L. McSherry, and M. Kim
Assistant Professor: C. L. Bohannon
Adjunct Professors: S. Couchman, M. Ezban, D. Hays, D. Hill, and B. Johnson
Professor Emeritus: B. Johnson

Web: **www.lar.vt.edu**

Overview

Landscape Architecture encompasses the design, analysis, planning, management, and stewardship of sustainable environments. Landscape architects design across a wide spectrum of projects: parks and gardens, community design, urban design and planning, green infrastructure, and regional planning, as well as at the scale of watersheds and natural systems. The work of the profession is grounded in the natural and social sciences, draws inspiration from nature and the arts, and is implemented through innovative design, site engineering, construction, land management, and environmental technologies. The Landscape Architecture Program guides students as they address some of the most important challenges of our time: climate change; healthy living and empathetic design; urbanization; re-imagining water, food, energy and transportation; green infrastructure; remediation of spoiled and disturbed sites; and preserving critical natural resources. We believe the work of the profession, at the critical intersection of natural and cultural systems, will be the most consequential of the design arts in the 21st century.

The core of the academic program is a rigorous sequence of design studios that allows students to explore a broad range of landscape architectural issues, contexts, and project types. Studios are accompanied by discussion, lecture, and laboratory courses that provide systematic and comprehensive coverage of the emerging body of knowledge related to technology, design theory, landscape ecology, and human/environment interaction. Off-campus options include a summer travel studio, study at the Washington Alexandria Architecture Center, and exchange programs with Tongji University in Shanghai, or University College, Dublin, Ireland, as well as an independent semester abroad and professional internships.

The Bachelor of Landscape Architecture (B.L.A.) is a five year first-professional degree program fully accredited by the Landscape Architecture Accreditation Board of the American Society of Landscape Architects. Graduates have a wide range of employment and professional opportunities including work in private practice, multidisciplinary firms, public agencies and municipalities, non-government organizations and non-profits.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for

graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Landscape Architecture. Landscape Architecture majors must attain a C- or better in their studio courses and the technology courses to advance to the next courses in these sequences.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (LAR)

1144: INTRODUCTION TO LANDSCAPE ARCHITECTURE
Overview of the profession of landscape architecture. Emphasis on the relation of people to the natural and built environment with particular attention to scale, forms, and space. (1H,1C)

1254: ENVIRONMENT AND NATURAL SYSTEMS
Introduction to the environment, natural systems with emphasis on their relationship to urban sustainability and resilience: natural elements, structures, patterns, natural systems, ecology, and landscape ecology. Impact of human actions and decisions on the environment and natural systems from global to local scale. Application of relevant theories and methods related to the environment and natural systems in planning and design. (3H,3C)

1264: SEEING, UNDERSTANDING & REPRESENTING LANDSCAPE AND THE BUILT ENVIRONMENT
Exploration of the natural and built environment through observation, interpretation and graphic representation of the landscape. Development of a range of graphic strategies and techniques with an emphasis on design thinking, iteration, and ethical issues expressed in the natural and built environment. (3H,3C)

2015-2016: LANDSCAPE ARCHITECTURE DESIGN STUDIO: PLACE AND PROCESS
Basic theory, principles, and methods of landscape design and site planning. 2015: Design theory involving two and three dimensional compositions. Mass/space relationships, principles of spatial design and techniques used to create landscape space. 2016: Design theory relating to landscape design and site planning. Design of small scale spaces in which the analysis of site, context and the requirements of human use are brought together in a creative synthesis. (1H,11L,6C)

2164: LANDFORM FUNCTION & AESTHETICS
Design principles and technology related to the creation of landforms for functional, aesthetic and environmentally sustainable purposes related to landscape design and construction process. Prerequisite: LAR 1264 or consent of instructor Pre: 1264. (2H,4L,4C)

2254: SOCIAL AND CULTURAL LANDSCAPES
Introduction to experiential and cultural content of designed landscapes. Physiological, functional, and psychological factors that affect experience of the landscape. Study of cultural values, attitudes, and philosophies that have shaped historic and contemporary landscapes. (3H,3C)

2554 (FREC 2554) (NR 2554): LEADERSHIP FOR GLOBAL SUSTAINABILITY
Leadership principles and humanities perspectives that help examine and engage global sustainable

development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

3015-3016: INTERMEDIATE LANDSCAPE DESIGN AND CONSTRUCTION DOCUMENTS
Development of intermediate site planning and design knowledge skills. 3015 focuses on site/project scale planning and design with emphasis on greenfield development sites and models of conversation oriented design/development. Pre: 2016 for 3015; 3015 for 3016. (1H,11L,6C)

3044: LAND ANALYSIS AND SITE PLANNING
Concepts, principles, and processes of land analysis and evaluation for physical planning and design. Approaches to spatial problem solving with an emphasis on data collection, evaluation, and synthesis using applicable technologies such as Geographic Information Systems (GIS). Analysis and synthesis of natural and socio-cultural systems at varying scales in the site planning and design process using Geodesign method. (3H,3C)

3154: WATERSHED SENSITIVE SITE DESIGN AND CONSTRUCTION
Examines soil and water resource issues related to landscape architectural site planning and design. Key topics include watershed sensitive site design, estimation and management of storm water runoff, rainwater conservation, design of open channel conveyances for site planning applications, and erosion and sedimentation control. Prerequisite: LAR 2164 or consent of instructor Pre: 2164. (2H,4L,4C)

3164: MATERIALS STRUCTURES DETAILS
Landscape construction theories and practices involving the selection of materials, design and placement of structures in the landscape and details critical to the creation of space and form. Addresses health, safety and welfare; sustainable materials and construction processes; and environmental performance. Pre-requisite: LAR 3154 or consent of instructor Pre: 3154. (3H,3L,4C)

3264: PEOPLE, COMMUNITY AND PLACE
An advanced course focusing on landscape/behavior interactions and implications for the design of outdoor environments. Study of factors that affect social interaction in community and public spaces; perceptions and needs particular to various sub-populations; ecological, social, and cultural approaches to theories of place and place attachment. Pre-requisite: LAR 2254 or instructor’s permission Pre: 2254. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4004: HISTORY AND THEORY OF LANDSCAPE ARCHITECTURE II
This course studies theoretical and practical developments in landscape architecture and related arts through investigation and analysis of design theory and philosophy, and built form. Pre: 2004 or permission of instructor. Pre: 2004. (3H,3C)

4014: LANDSCAPE PLANNING AND MANAGEMENT
Links landscape architectural design and construction documents through integrating site design from schematic design through design development to construction documentation drawings and technical specifications. Landscape design and technology covered in preceding design and technology courses is combined with construction principles and practices in preparation of site design and set of construction documents. Prerequisites may be waived with permission of instructor. Pre: 3016, 3164. (1H,11L,6C)

4034: EVOLUTION OF THE AMERICAN LANDSCAPE

Examine and interpret physical changes in the rural and urban landscapes of the United States as they reflect cultural values; technologic innovations; immigration patterns; the roles of diverse professions over time; changing views of use, conversation and preservation of national resources; and expectations for places of live, work and play using an iterative writing process and reflective course discussions. (3H,3C)

4084: LANDSCAPE DESIGN AND PLANNING STUDIO
This course is an advanced studio that enables students to address landscape architectural design and planning issues in various contexts and at a range of scales. Pre: 3016 or permission of instructor. Landscape Architecture majors must take minimum of 6 credits. May be repeated to a maximum of 12 credit hours. Pre: 3016. (1H,11L,6C)

4094: SENIOR PROJECT
A capstone of a five-year design studio sequence, the senior project is a comprehensive landscape architecture design project selected and completed by the student under the direction of a faculty advisor. Senior projects are reviewed and evaluated by the program faculty. Repeatable with a maximum of 12 credits. Variable credit course. X-grade allowed.

4124 (ARCH 4044): PROFESSIONAL PRACTICE
Introduction to scope and diversity of the building enterprise, addressing private and public macroeconomic, industrial, technical, professional, and regulatory institutions. Analysis of historic evaluation of professional roles and practices; emergence of new modes of practice, including innovative facilities procurement methods. (3H,3C)

4254: THEORIES OF LANDSCAPE ARCHITECTURE
Critical examination of theories relevant to landscape architectural design and the inter-relationship between theory and practice. Evolution of theory with respect to built works. Overview of concurrent design theories and philosophies in the related arts. Pre-requisite: Senior standing or instructor’s permission. (3H,3C)

4304: TOPICS IN LANDSCAPE ARCHITECTURE
Topics in landscape architecture history, theory and design methods is an advanced course focusing upon issues facing the professional practice of landscape architecture today. Special emphasis on methods of analysis and interpretation including application of creative techniques, analogous thinking, computer-aided procedures and information handling in landscape architecture design and practice. Pre: 3015 and 3016 or permission of instructor. May be repeated with different content for a maximum of 12 credits. Pre: (3015, 3016). (3H,3C)

4324: LANDSCAPE ARCHITECTURE TECHNOLOGY III-CONSTRUCTION DOCUMENTS
This course provides the link between landscape architectural design and construction documentation. Landscape technology covered in preceding technology courses is combined with information on construction principles and practices in the preparation of landscape architectural construction drawings and technical specifications. Pre: 4244. (2H,4L,4C)

4554 (BSE 4554) (FREC 4554) (HORT 4554) (SPIA 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: HORT 2134 or FREC 2134. (3H,3C)

4705-4706: LANDSCAPE DESIGN AND PLANNING
Theories, methods, techniques, and tools relating to the planning and design of sites, communities, and regional landscapes. 4705: Emphasis on the development of design ability through the study of: two- and three-dimensional design, principles and elements of spatial composition, and theories and techniques for planning and design of small sites. 4706: Emphasis on the evaluation of land resources and the allocation of land uses within large complex sites and regional landscapes. Theories and techniques of site planning and community design are explored. (1H,8L,5C)

4974: INDEPENDENT STUDY

Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Exploring Life Sciences

Overview

Advisor: Cindy Beatty
(540) 231-9671, beatty@vt.edu

Jennifer Carr
(540) 231-8127, jjc@vt.edu

Overview

The College of Agriculture and Life Sciences offers a program for students who are exploring their major during the first two years at Virginia Tech. This flexibility allows students to explore career opportunities in different fields, to meet faculty in different departments, and to investigate the wide-range of majors and options within the college as well as in the university. Working closely with an advisor in the Office of Academic Programs, students will take foundation courses required of most majors (biological sciences, math, English and chemistry) in the college and be encouraged to take exploratory courses in different departments to sharpen their career focus.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Mathematics

Chair: Eric de Sturler
Associate Chair: R. C. Rogers
Director for Undergraduate Programs: L. Zietsman
Graduate Director: T. Warburton
A.V. Morris Professor: S. Gugercin
John K. Costain Faculty Chair and Professor: T. Warburton
Hatcher Professor of Mathematics: J. A. Burns
Professors: S. Adjerid, C. A. Beattie, J. Borggaard, E. de Sturler, A. Elgart, M. Embree, P. E. Haskell, T. L. Herdman, T. Iliescu, J. U. Kim, M. Klaus, T. Lin, P. A. Linnell, N. Loehr, G. Matthews, A. Norton, R. C. Rogers, J. F. Rossi, M. Shimozono, S. Sun, J. Turner, and T. Warburton
Associate Professors: N. Abaid, J. Chung, Ma. Chung, S. Ciupe, C. Mihalcea, P. Wapperom, M. Wawro, P. Yue, and L. Zietsman
Assistant Professors: L. Childs, M. Fraas, R. Hewett, E. Johnson, H. Liu, E. Martin, D. Orr, E. Palsson, O. Saucedo, W. Sun, and Y. Yang
Collegiate Assistant Professors: R. Arnold, E. Ufferman, and J. Wilson
Visiting Assistant Professors: P. Manoharan and R. Steiner
Patricia Ann Caldwell Post-Doctoral Fellow and Visiting Assistant Professor: R. Singh
Senior Instructors: D. Agud, S. Anderson, T. A. Bourdon, S. Hagen, H. Hart, and J. Schmale
Advanced Instructors: J. Clemons, J. Hurdus, E. Jasso Hernandez, N. Robbins, E. Saenz Maldonado
Instructors: T. Asfaw, T. Balkew, S. Barreto, J. Brooks, G. Cerezo, My. Chung, J. England, O. Kakron, H. Farhat, S. Farmer, N. Gildersleeve, S. Hammer, K. Karcher, K.

Kasebian, C. Letona, M. Ouliaei-Nia, E. Rappold, S. Silber, J. St.Clair, J. Thompson, J. Truman, C. Withrow, S. Yasuda, and K. Zachrich
Postdoctoral Associates: J. Jiang, Pranial, and D. Skabelund
Lecturers: V. Kairamkonda, W. Reilly, A. Sibol, and E. Widdowson
Career Advisor: L. Zietsman
Scholarship Chair: J. Kim

Web: **www.math.vt.edu**

Overview

Mathematics is essential to a clear and complete understanding of virtually all phenomena. Its precision, depth, and generality support the development of critical thinking and problem-solving skills. The study of mathematics provides the ability to describe applied problems quantitatively and to analyze these problems in a precise and logical manner. This is a principal reason behind the strong demand for mathematicians in government and industry. Essentially all complex problems, whether physical, social, or economic, are solved by designing a mathematical model, analyzing the model, and determining computational algorithms for an efficient and accurate approximation of a solution. Each of these phases is mathematical in nature. For example, if a problem deviates from a standard form, a mathematician should be able to adjust the usual mathematical treatment of the problem to accommodate the deviation. In this case mathematical training provides a practical preparation for a career in today's changing world. Moreover, it is especially valuable because it is an education that equips one to continue to adapt to new situations.

Mathematicians typically are employed as applied mathematicians in their specialty areas. Our recent mathematics graduates have been approximately equally divided among government and industry, graduate school, and teaching. There are four different paths or options that a student may follow towards a B.S. in Mathematics: 1) the Traditional Option; 2) the Applied Computational Mathematics Option (ACM); 3) the Applied Discrete Mathematics Option (ADM); and 4) the Mathematics Education Option (MSTR).

The Traditional Option, as its name implies, yields a broad and flexible background in mathematics. The other three options are more specialized. The ACM option is designed for students primarily interested in computational mathematics and its applications to engineering and the natural and social sciences. The ADM option is designed for students primarily interested in areas of applied mathematics closely associated with computer science. The Mathematics Education Option is designed for students who want to be certified to teach secondary mathematics.

Often students will begin their studies in the Traditional Option and later change to one of the other three options when they become more sure of the path they wish to pursue. One, however, can acquire many aspects of the three specialized options within the Traditional Option, because it also requires some degree of specialization in an applications area and provides career development features. The three specialized options are each less general, but bring particular career paths into sharper focus. Each of the four options provides an excellent foundation for graduate study, either in mathematics or in an applications area. Handbooks for each of the options, as well as mathematics career information, are available upon request.

Approximately $45,000 in Hatcher, Morris, Layman, Rollins, Steeneck, Caldwell, Wells, Oehring, Eckert, Persinger, Kim, Kimball, and Roselle scholarships is awarded annually to mathematics majors at Virginia Tech: $5,000 for incoming freshmen and $40,000 for continuing undergraduates. Information on the scholarships is available from the scholarship chairman in mathematics.

The Cooperative Education Program is also available to qualified candidates, and students wishing to mix practical experience with their formal course studies are encouraged to investigate this option. For more information, contact Career Services at Virginia Tech.

The Mathematics Department firmly believes that mathematics is not only useful and beautiful, but also fun. The department sponsors student chapters of MAA (Mathematical Association of America), SIAM (Society for Industrial and Applied Mathematics), Pi Mu Epsilon (the national mathematics honorary society), and AWM (Association for Women in Mathematics). As well as social activities, these groups sponsor speakers to talk on how mathematics is used in their work. Each fall, Virginia Tech also sponsors the Virginia Tech Regional Mathematics Contest. In addition, students (not all of whom are mathematics majors) annually receive organized preparation and compete in the nationwide William Lowell Putnam Competition and the international Mathematical Contest in Modeling. Individual undergraduate research projects are available to talented students, and a Layman Prize is awarded for the best research project. An overall outstanding senior, as well as an outstanding senior for each option, is recognized each year.

The Honors Program in Mathematics provides outstanding undergraduate majors the opportunity for an enriched academic environment. Through honors courses, an honors project, individual association with the faculty and honors advisors, and other perquisites, the honors student in mathematics enjoys a valuable advantage in the undergraduate experience. Moreover, in coordination with the head of Mathematics and the dean of Science, the honors student may design her/his own individual set of graduation requirements.

In addition to the four undergraduate-degree options, the department also offers the M.S. and Ph.D. Moreover, for qualified students, a combined program is available that leads to both a B.S. and an M.S. in Mathematics. This program saves a year from the usual time required for a B.S. and an M.S. done separately. Students in the Education Option obtain a B.S. in Math and an M.A. in Education by completing four years of undergraduate study and a fifth year in education for a full secondary certification.

The minor is designed to provide recognition for those students who take a program of study in mathematics above the normal requirements of their disciplines.

Bachelor of Science in Mathematics

Requirements

Note that the Calculus curriculum is in transition and there are two possible paths through Calculus. We distinguish the two paths as follows: **Path 1** for students who have received credit for MATH 1205 prior to fall 2014 and **Path 2** for students who have not received credit for MATH 1205 prior to fall 2014.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Those courses listed in the catalog under the subtitles "Basic Sequences for Students in Agriculture, Architecture, Biology, Business, and Liberal Arts and Human Sciences" and "Electives (may not be taken by Mathematics Majors)" may not be used for graduation in mathematics. Special exceptions to this

exclusion must have the approval of the head of the department of mathematics.

In order to enroll in 3034, a student must obtain a C or better in MATH 2114 or obtain a C or better MATH 2114H or obtain a C or better in MATH 2405H.

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the department head.

Prospective Student Website

A great deal of further information on the Mathematics Program and on mathematical careers can be found on our website at **www.math.vt.edu**.

Minor in Mathematics

Requirements

A total of 25 semester hours of the following mathematics courses for students who follow Path 1 : Calculus (1205-1206, 1224, 2224); Linear Algebra & ODE's: (1114, 2214); and **9 hours of approved mathematics courses numbered 3000 or higher** or selections from CMDA 3605, 3606, and 4604. Students who follow Path 2, should take a total of 26 semester hours of the following mathematics courses Calculus (1225-1226, 2204) ; Linear Algebra &ODEs (2114, 2214) ; and **9 hours of approved mathematics courses numbered 3000 or higher or selections from CMDA 3605, 3606, and 4604**. Duplications are prohibited. The student must have a 2.00 average in courses used for the minor, none of which may be taken pass/fail.

Advanced Placement

A student following Path 1 may obtain advanced placement credit for 1205, or 1206, and students following Path 2 may obtain advanced placement credit for 1225 or 1226. The Mathematics Department strongly encourages calculus students to take the C.E.E.B. advanced placement test in calculus.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Mathematics can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (MASC)

1024: MATHEMATICS, A LIBERAL ARTS APPROACH
This is the first course in a sequence that is intended to give those students who will not make extensive use of the Mathematical Sciences in their specialties some insight into Mathematics, Computer Science, and Statistics in an integrated setting. Topics include set theory, number theory, and modular arithmetic. (3H,3C)

1044: COMPUTER SCIENCE, A LIBERAL ARTS APPROACH
Intended to provide those students who will not make extensive use of the mathematical sciences in their specialties some insight into the concepts of computer science. Topics include introduction to computer architecture, operating systems, programming languages, and algorithms; history of computing; computer applications in the modern world. Prior credit for CS 1114 or any other Computer Science course at the 2000 level or higher precludes credit for 1044. (3H,3C)

Undergraduate Course Descriptions (MATH)

1004: DISCOVERING MATHEMATICS I
Introduction to the scope and applicability of mathematics and its many sub-disciplines. Introduction to the process of thinking, learning, and writing as a mathematician through topics such as logic systems, recreational mathematics, LaTeX programming, history, ethics, open problems, and research in mathematics. Also includes advising topics such as planning a Virginia Tech course of study. P/F only. Math majors. Pass/Fail only. (1H,1C)

1014: PRECALCULUS WITH TRANSCENDENTAL FUNCTIONS
Precalculus college algebra, basic functions (algebraic, exponential, logarithmic, and trigonometric), conic sections, graphing techniques, basic probability. Usage of mathematical models, analytical calculations, and graphical or numerical representations of data to analyze problems from multiple disciplines that address intercultural and global challenges in areas such as chemistry, environmental science, the life sciences, finance, and statistics. Use of spreadsheet software. Two units of high school algebra and one of plane geometry are required. (3H,3C)

1025-1026: ELEMENTARY CALCULUS
Quantitative and computational thinking to address relevant global issues. Unified calculus course covering techniques and applications of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for the life sciences. 1025: Differential calculus, graphing, applications for the life sciences, use of spreadsheet software. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit of trigonometry and precalculus. 1026: Integral calculus, numerical techniques, elementary differential equations, applications for the life sciences, use of spreadsheet and scientific software. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1026 and 1226. (3H,3C)

1044: DISCOVERING MATHEMATICS II
Introduction to the scope and applicability of mathematics and its many sub-disciplines. Introduction to the process of thinking, learning, and writing as a mathematician through topics in pure and applied mathematics and a brief experience with mathematical research. Also includes advising topics such as planning a Virginia Tech course of study. Math majors. (2H,2C)

1114: ELEMENTARY LINEAR ALGEBRA
Euclidean vectors, complex numbers, and topics in linear algebra including linear systems, matrices, determinants, eigenvalues, and bases in Euclidean space. This course, along with 1205-1206 and 1224, constitutes the freshman science and engineering mathematics courses. 2 units of high school algebra, 1 unit of geometry, 1/2 unit each of trigonometry and pre-calculus required. A student cannot earn credit for 1114 if taken after earning credit for 2114. (2H,2C)

1225-1226: CALCULUS OF A SINGLE VARIABLE
Quantitative and computational thinking to address relevant intercultural and global issues. Unified calculus course covering techniques of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for science and engineering. 1225: limits, continuity, differentiation, transcendental functions, applications of differentiation, introduction to integration. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit each of trigonometry and precalculus, and placement by Math Dept. 1226: techniques and applications of integration, trapezoidal and Simpson’s rules, improper integrals, sequences and series, power series, parametric curves and polar coordinates, software-based techniques. A student can earn credit for at most one of 1525 and 1225. A student can earn credit for at most 1026 and 1226. (4H,4C)

1454: INTRODUCTION TO MATHEMATICAL PROBLEM-SOLVING
An introduction to mathematical problem-solving strategies involving complex problems and subproblems. Examination of supporting data. Implementation of solution strategies through computer programming. Topics include logic, iterative process and recursion, Monte Carlo integration, random walks, visualization, computational geometry and graph theory. Graphical representation of mathematical information. Co: 1225. (3H,3C)

1524: BUSINESS CALCULUS
Differential calculus techniques for functions of one and two variables. Emphasis on graphs, rates of change, and optimization of linear, quadratic, exponential, and logistic functions. Terminology and applications for business, including spreadsheet software. Mathematical models of real-world business problems, including discrete and continuous models, that address intercultural and global challenges in such areas as finance, marketing, and accounting. Assumes 2 units of high school algebra and 1 unit of geometry. (4H,4C)

1525-1526: ELEMENTARY CALCULUS WITH MATRICES
1525: Linear, quadratic, exponential and logarithmic functions. Differential calculus with graphical interpretation. Terminology and applications for business, including spreadsheet software. 1526: Integration, substitution and approximation methods. Matrix algebra and solving systems of equations. Partial derivatives and optimization for functions of several variables. Applications for business, including spreadsheet software. Assumes 2 unit of high school algebra and 1 unit of plane geometry. A student can earn credit for at most one of 1525 and 1225. A student cannot earn credit for 1525 if taken after earning credit for 1025. A student cannot earn credit for 1526 if taken after earning credit for 1026, 1114, 1226, or 2114. (3H,3C)

1535-1536: GEOMETRY AND MATHEMATICS OF DESIGN
A standard first-year mathematics sequence for architecture majors. Mathematical models of real-world problems, including discrete and continuous models, that address relevant global challenges in such areas as urban planning, building construction, and home design. 1535: Euclidean geometry, trigonometry, sequences and the golden ratio, graph theory, tilings, polygons and polyhedra, applications for 2- and 3-dimensional design and construction, use of geometric software. 1536: vectors in the plane and space, descriptive and projective geometry, differential and integral calculus, applications for 2- and 3-dimensional design and construction, including areas, volumes, centroids, and optimization. Assumes 2 unites of high school algebra and 1 unit of high school geometry. (3H,3C)

1614: NUMBERS AND OPERATIONS FOR TEACHERS
Study of the nature and structure of numbers for prospective elementary and middle school teachers; number theory, number systems, operations and algebraic thinking, problem solving, and mathematical modeling. 1614 may not be taken by math majors for credit. (3H,3C)

1624: GEOMETRY FOR TEACHERS
Study of key geometry concepts for prospective elementary and middle school teachers; multiple perspectives including transformational, coordinate, Euclidean and analytical geometry; geometric modeling; geometric and spatial reasoning. 1624 may not be taken by math majors for credit. Pre: 1614. (3H,3C)

2004 (ME 2004): ENGINEERING ANALYSIS USING NUMERICAL METHODS
Numerical methods applied to engineering analysis. Numerical techniques including root finding, linear algebra, integration, ordinary differential equations, curve fitting, discrete Fourier transforms, optimization. Structured programming and iterative problem-solving using a high-level environment such as Matlab. Pre: ENGE 1216, MATH 1226, MATH 2114. (2H,3L,3C)

2024: INTERMEDIATE CALCULUS
Continuation of Math 1025-1026. Calculus for functions of several variables, differential equations, sequences and series. Applications for the life sciences. Use of spreadsheet software. A student cannot earn credit for 2024 if taken after earning credit for 2214. Pre: 1026. (3H,3C)

2114: INTRODUCTION TO LINEAR ALGEBRA
Vector and matrix algebra systems of linear equations, linear equations, linear independence, bases, orthonormal bases, rank, linear transformations, diagonalization, implementation with contemporary software. Math 1226 or a grade of at least B in VT MATH 1225. A student can earn credit for at most one of 2114 and 2405H. Pre: 1225 or 1226. (3H,3C)

2114H: INTRODUCTION TO LINEAR ALGEBRA
Vector and matrix algebra systems of linear equations, linear equations, linear independence, bases,

orthonormal bases, rank, linear transformations, diagonalization, implementation with contemporary software. Math 1226 or a grade of at least B in VT MATH 1225. A student can earn credit for at most one of 2114H and 2405H. Pre: 1225 or 1226. (3H,3C)

2204: INTRODUCTION TO MULTIVARIABLE CALCULUS
Calculus for functions for several variables. Planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, software-based techniques. A student can earn credit for at most one of 2204 and 2406H. A student can earn credit for at most one of 2024 and 2204. A student can earn credit for at most one of 2204 and CMDA 2005. Pre: 1226. (3H,3C)

2204H: INTRODUCTION TO MULTIVARIABLE CALCULUS
Calculus for functions of several variables. Planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, software-based techniques. A student can earn credit for at most one of 2204H and 2406H. A student can earn credit for at most one of 2024 and 2204H. A student can earn credit for at most one of 2204H and CMDA 2005. Pre: 1226. (3H,3C)

2214: INTRODUCTION TO DIFFERENTIAL EQUATIONS
Unified course in ordinary differential equations. First-order equations, second-and-higher-order constant coefficient linear equations, systems of first-order linear equations, and numerical methods. Mathematical models describing motion and cooling, predator-prey population models, SIR-models, mechanical vibrations, electric circuits, rates of chemical reactions, radioactive decay. Quantitative and computational thinking to address relevant intercultural and global issues. A student can earn credit for at most one of 2214 and 2406H. A student can earn credit for at most one of 2214 and CMDA 2006. Pre: 1114 or 2114 or 2114H or 2405H, 1226. (3H,3C)

2214H: INTRODUCTION TO DIFFERENTIAL EQUATIONS
Unified course in ordinary differential equations. First-order equations, second-and-higher-order constant coefficient linear equations, systems of first-order linear equations, and numerical methods. Mathematical models describing motion and cooling, predator-prey population models, SIR-models, mechanical vibrations, electric circuits, rates of chemical reactions, radioactive decay. Quantitative and computational thinking to address relevant intercultural and global issues. A student can earn credit for at most one of 2214 and 2406H. A student can earn credit for at most one of 2214 and CMDA 2006. Pre: 1114 or 2114 or 2114H or 2405H, 1226. (3H,3C)

2224: MULTIVARIABLE CALCULUS
Partial differentiation, multiple integration, and infinite series. Partially duplicates MATH 2204, 2024, and 2016. Pre: (1206 or 1206H or 2015 or 1026), (1224 or 1224H). (3H,3C)

2224H: MULTIVARIABLE CALCULUS
Pre: (1206 or 1206H or 2015 or 1026), (1224 or 1224H). (3H,3C)

2405H-2406H: MATHEMATICS IN A COMPUTATIONAL CONTEXT
Unified course covering topics from linear algebra, differential equations, and calculus for functions of several variables. Comprises the standard second year mathematics courses for science and engineering. 2405H: Vector and matrix algebra, systems of linear equations, linear independence, bases, orthonormal bases, rank, linear transformations and diagonalization. Ordinary linear homogeneous differential equations, implementation with contemporary software. 2406H: Ordinary nonhomogeneous differential equations, calculus for functions of several variables, planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, with software-based techniques. A student can earn credit for at most one of 2114, 2114H, and 2405H. A student can earn credit for at most one of 2204, 2204H, and 2406H. A student can earn credit for at most one of 2214, 2214H, and 2406H. Pre: 1226 for 2405H; 2405H for 2406H. (5H,5C)

2534: INTRODUCTION TO DISCRETE MATHEMATICS
Emphasis on topics relevant to computer science. Topics include logic, propositional calculus, set theory, relations, functions, mathematical induction, elementary number theory and Boolean algebra. Does not

carry credit for mathematics majors, but may be used as though it were a 3000-level elective course for the mathematics minor. Two units of high school algebra, one unit of geometry, one-half unit each of trigonometry and precalculus mathematics required. A student can earn credit for at most one of 2534 and 3034. Pre: CS 1114 or ECE 1574 or ECE 1004. (3H,3C)

2644: MATHEMATICS TUTORING
An introduction to mathematics tutoring. Course activities include the development of listening and questioning skills, assessment of a student's mathematical difficulties, and an exploration of teaching and learning processes. In a weekly journal, students will reflect on their tutoring experiences to develop and refine teaching goals and skills. A concurrent mathematics tutoring experience is required. Pre: 1226. (1H,1C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2984H: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Variable credit course.

3034: INTRODUCTION TO PROOFS
Practice in writing mathematical proofs. Exercises from set theory, number theory, and functions. Specific topics include set operations, equivalence relations, mathematical induction, the division algorithm and images and pre-images of sets. A student can earn credit for at most one of 2534 and 3034. Pre: 2114 or 2114H or 2405H. (3H,3C)

3054: PROGRAMMING FOR MATHEMATICAL PROBLEM SOLVING
An Introduction to computer programming designed for mathematics majors. Variable types, data structures, control flow and program structure. Procedural, functional and objective-oriented programming paradigms for solution of a variety of mathematical problems. Co: MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006. (3H,3C)

3124: MODERN ALGEBRA
Introductory course in groups, rings and fields. Pre: 3034. (3H,3C)

3134: APPLIED COMBINATORICS AND GRAPH THEORY
Emphasis on concepts related to computational theory and formal languages. Includes topics in graph theory such as paths, circuits, and trees. Topics from combinatorics such as permutations, generating functions, and recurrence relations. Pre: 1226, (2534 or 3034). (3H,3C)

3144: LINEAR ALGEBRA I
Introductory course in linear algebra. Abstract vector spaces, linear transformations, algorithms for solving systems of linear equations, matrix analysis. This course involves mathematical proofs. Pre: (3034 or 2534), (2114 or 2114H or 2405H). (3H,3C)

3214: CALCULUS OF SEVERAL VARIABLES

Fundamental calculus of functions of two or more variables. Implicit function theorem, Taylor expansion, line integrals, Green's theorem, surface integrals. Pre: 2224 or 2224H or 2204 or 2204H or 2406H or CMDA 2005. (3H,3C)

3224: ADVANCED CALCULUS
Theory of limits, continuity, differentiation, integration, series. 3224 duplicates 4525. Pre: (2224 or 2224H or 2204 or 2204H or 2406H or CMDA 2005), MATH 3034. (3H,3C)

3414 (CS 3414): NUMERICAL METHODS
Computational methods for numerical solution of non-linear equations, differential equations, approximations, iterations, methods of least squares, and other topics. A grade of C or better required in CS prerequisite 1044 or 1705. A student can earn credit for at most one of 3414 and 4404. Pre: (CS 1044 or CS 1705 or CS 1114 or CS 1124), MATH 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)

3574: APPLIED COMPLEX VARIABLES
Arithmetic of complex numbers. Geometry of the complex plane. Geometry of exponentiation and roots. Complex exponential, trigonometric and hyperbolic functions. Continuity and differentiability. Analytic and harmonic functions. Pre: 2204 or 2204H or 2224 or 2224H. (1H,1C)

3624: EARLY TEACHING EXPERIENCE IN MATHEMATICS
An early field experience designed for mathematics students in the mathematics education option. Principles for school mathematics. Secondary school classroom experience and experience-based research. Pre: Junior standing and permission of the instructor. (4H,4C)

4044: HISTORY OF MATHEMATICS
Historical development of mathematics from antiquity to modern times. Senior standing in mathematics required. (3H,3C)

4124: INTRODUCTION TO ABSTRACT
ALGEBRA An introduction to the theory of groups and rings. Topics include normal subgroups, permutation groups, Sylow's Theorem, Abelian groups, Integral Domains, Ideals, and Polynomial Rings. Pre: 3124. (3H,3C)

4134: NUMBER THEORY
Divisibility, congruencies, multiplicative functions, primitive roots, quadratic reciprocity. Pre: 2534 or 3034 or 3134. (3H,3C)

4144: LINEAR ALGEBRA II
Second course in linear algebra. Similarity invariants, Jordan canonical form, inner product spaces, self-adjoint operators, selected applications. Pre: 3144. (3H,3C)

4175,4176: CRYPTOGRAPHY
Introduction to classical and modern symmetric-key cryptography; alphabetic ciphers, block ciphers and stream ciphers; background in modular arithmetic and probability; perfect secrecy; linear and differential cryptanalysis; Advanced Encryption Standard; hashing. Pre: Experience with either a programming language or a computer algebra system. Pre: (3034 or 3124 or 3134 or 3144 or 3224 or 4134 or CMDA 3605) for 4175; 4175 or CM DA 3606 or (MATH 3034, MATH 3124) or (MATH 3034, MATH 3134) or (MATH 3034, MATH 3144) or (MATH 3034, MATH 3224) or (MATH 3034, MATH 4134) or (MATH 3124, MATH 3134) or (MA TH 3124, MATH 3144) or (MATH 3124, MATH 3224) or (MATH 3124, MATH 4134) or (MATH 3134 , MATH 3144) or (MATH 3134, MATH 3224) or (MATH 3134, MATH 4134) or (MATH 3144, MATH 3224) or (MATH 3144, MATH 4134) or (MATH 3224, MATH 4134) for 4176. (3H,3C)

4225-4226: ELEMENTARY REAL ANALYSIS
Real number system, point set theory, limits, continuity, differentiation, integration, infinite series, sequences and series of functions. Pre: 3224 for 4225; 4225 for 4226. (3H,3C)

4234: ELEMENTARY COMPLEX ANALYSIS
Analytic functions, complex integration, series representation of analytic functions, residues, conformal

mapping, applications Pre: 3224. (3H,3C)

4245-4246: INTERMEDIATE DIFFERENTIAL EQUATIONS
Solution techniques, linear systems, the matrix exponential, existence theorems, stability, non-linear systems, eigenvalue problems. Pre: 3224. (3H,3C)

4254: CHAOS AND DYNAMICAL SYSTEMS
Survey of basic concepts in chaotic dynamical systems. Includes material on bifurcation theory, conjugacy, stability, and symbolic dynamics. Pre: 3224. (3H,3C)

4324: ELEMENTARY TOPOLOGY
Basic concepts of topological spaces, continuous functions, connected spaces, compact spaces, and metric spaces. Pre: 3124, 3224. (3H,3C)

4334: COLLEGE GEOMETRY
Transformational approach to Euclidean geometry including an in-depth study of isometries and their application to symmetry, geometric constructions, congruence, coordinate geometry, and non-Euclidean geometries. Pre: 1114 or 2114 or 2114H or 2405H, 1226. (3H,3C)

4404 (AOE 4404): APPLIED NUMERICAL METHODS
Interpolation and approximation, numerical integration, solution of equations, matrices and eigenvalues, systems of equations, approximate solution of ordinary and partial differential equations. Applications to physical problems. A student can earn credit for at most one of 3414 and 4404. Pre: 4564, ESM 2074. (3H,3C)

4414 (CS 4414): ISSUES IN SCIENTIFIC COMPUTING
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines. Pre: (2214 or 2214H or 2406H or CMDA 2006), MATH 3214, (CS 2114 or MATH 3054). (2H,3L,3C)

4425-4426: FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS
Separation of variables for heat, wave, and potential equations. Fourier expressions. Application to boundary value problems. Bessel functions. Integral transforms and problems on unbounded domains. Pre: 2406H or CMDA 2006 or MATH 2214 or MATH 2214H, MATH 3224 for 4425; 4425 for 4426. (3H,3C)

4445,4446: INTRODUCTION TO NUMERICAL ANALYSIS
4445: Vector spaces and review of linear algebra, direct and iterative solutions of linear systems of equations, numerical solutions to the algebraic eigenvalue problem, solutions of general non-linear equations and systems of equations. 4446: Interpolation and approximation, numerical integration and differentiation, numerical solutions of ordinary differential equations. Computer programming skills required. Pre: 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H) or (MATH 2204 or MATH 2204H) for 4445; 2406H or (CMDA 2005, CMDA 2006) or (MA TH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H) for 4446. (3H,3C)

4454: APPLIED MATHEMATICAL MODELING
Analysis of classical and modern applications of mathematics in the physical, biological and social sciences. Emphasis on problem formulating, modeling, solving, simulating, and analyzing results. Programming language required. Pre: 3214. (3H,3C)

4564: OPERATIONAL METHODS FOR ENGINEERS
Laplace transformations, Fourier series, partial differential equations and separation of variables, boundary value problems, and Sturm-Liouville theory. Pre: (2214 or 2214H) or 2406H or CMDA 2006. (3H,3C)

4574: VECTOR AND COMPLEX ANALYSIS FOR ENGINEERS

Vector Analysis: Green's theorem, potential theory, divergence, and Stokes' theorem. Complex Analysis: Analyticity, complex integration, Taylor series, residues, conformal mapping, applications. 4574 may not be taken by math majors for credit. Pre: 2224 or 2204 or 2204H. (3H,3C)

4625,4626: MATHEMATICS FOR SECONDARY TEACHERS
Course activities will emphasize the curricular themes of problem solving, reasoning and proof, communication, connections, and representation. 4625: Topics in discrete mathematics and algebra from a secondary teaching perspective. 4626: Topics in trigonometry, geometry, measurement, statistics, and probability from a secondary teaching perspective. Pre: 3034. (3H,3C)

4644: SECONDARY SCHOOL MATHEMATICS WITH TECHNOLOGY
Use and impact of technology in secondary mathematics curriculum. Various technologies including graphing calculators, calculator based laboratory and probes (CBLs), computer algebra systems, spreadsheets, dynamic geometry software and the Internet will be used to explore secondary mathematical concepts from an advanced viewpoint. Pre: 3034. (3H,3C)

4664: SENIOR MATH EDUCATION SEMINAR
A review of basic principles and problem-solving techniques in the eleven topics covered by the Praxis II (Mathematics Content Knowledge) examination. Passing the Praxis II examination prior to student teaching is a state requirement for all students seeking secondary licensure. Passing Praxis I required. Pre: 3124. (2H,2C)

4754: INTERNSHIP
May be repeated for a maximum of 12 credits. Pass/Fail only. Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Mechanical Engineering

Head: Azim Eskandarian
William S. Cross Professor: D. K. Tafti
Nicholas & Rebecca Des Champs Professor: A. Eskandarian
George R. Goodson Professor: R. Pitchumani
Lewis A. Hester Professor: L. Mahajan
Samuel P. Langley Professor: C.R. Fuller
W. Martin Johnson Professor: A.J. Kurdila
Chris C. Kraft Professor of Engineering: W. F. Ng
J. Bernard Jones Professor: W.F. O'Brien
Rolls Royce Professor: C. Son
L. S. Randolph Professor: R. G. Parker
Dan Pletta Professor: M. Ahmadian
Professors: M. Ahmadian, R.A. Burdisso, T.E. Diller, A. Eskandarian, C.R. Fuller, T. Furukawa, A. Haghighat, W. Hardy, A.J. Kurdila, A. Leonessa, R.L. Mahajan, D.J. Nelson, W.F. Ng, W.F. O'Brien, R. Parker, M.R. Paul, R. Pitchumani, R. Qiao, M.J. Roan, C. Sandu, C. Son, D.K. Tafti, S. Taheri, M.R. von Spakovsky, J. Zhang, and L. Zuo
Associate Professors: C. Ban, B. Behkam, P. Ben-Tzvi, J.H. Bohn, J. Cheng, C.L. Dancey, M.W. Ellis, J.B. Ferris, S. Huxtable, M.E.F. Kasarda, K.B. Kochersberger, R. Mueller, A.S. Nain, R. Qiao, S.C. Southward, P. Tarazaga, B. Vick, R.L. West, A.L. Wicks, and C.B. Williams
Assistant Professors: P. Acar, A. Asbeck, O. Berry, K.A. Hamed, E. Komendera, L. Li, Z. Li, Y. Liu, J. Meadows, R. Mirzaeifar, J. Palmore, and X. Zheng.
Assistant Professor of Practice: R. Long

Associate Professor of Practice: R. Ott, M.A. Pierson, S. Ranganathan, and L. Vick
Professors Emeritus: L.J. Arp, R.A. Comparin, N.S. Eiss, R.E. Hedgepeth, C.J. Hurst, J.B. Jones, R.G. Kirk, R.G. Leonard, J. R. Mahan, L.D. Mitchell, R. Mitchiner, J. Moore, A. Myklebust, T.F. Parkinson, F.J. Pierce, J.R. Thomas, W.C. Thomas, and R.J. Whitelaw
Adjunct Professors: R. Anderl (TU Darmstadt), P.G. Brolinson (Edward Via College of Osteopathic Medicine), D. Carlson (Lord Corp.), J. Funk (Biodynamic Research Corp.), M.J. Hampe (TU Darmstadt), T. Kress (BEST Engineering), D. Rabe (Air Force Research Lab), and B. Sanders (Air Force Research Lab)

Web: **www.me.vt.edu**

Nature of the Profession

Mechanical engineering is the broadest of the engineering professions. Because of the breadth of the ME discipline, mechanical engineers work in a wide variety of technical areas and are employed in a range of job functions. Specialty areas within the mechanical engineering discipline include, among many others, acoustics, biomechanics, CAD, controls, energy conversion and energy management, HVAC, materials, mechanical design, mechatronics, nuclear engineering, robotics and automation, and turbomachinery. The actual job functions which mechanical engineers perform vary widely as well. ME's work in design, research and development, manufacturing, service and maintenance, as well as technical sales, in almost every industry. Many are in management and administration. Many mechanical engineering graduates go on to more advanced degrees, or continue their education in other fields, such a law or business.

Employment Opportunities

Because of the diversity and breadth of the mechanical engineering profession, ME graduates find employment in a wide variety of industries, laboratories, and consulting firms. This results in a relatively stable job market that is not dependent upon a single particular industry. The textile, petroleum, chemical, electronic, automotive, aerospace, power generation, HVAC, and manufacturing industries hire large numbers of mechanical engineering graduates and the starting salaries for ME's are very competitive with the other engineering disciplines.

Because of the wide diversity of specialties and job functions any two mechanical engineers might have significantly different day-to-day activities and responsibilities. Some may be concerned with very large engineering systems while others are working with small and even microscale devices and components; some work might call for highly analytical or mathematical approaches while other work might be more amenable to experimental or empirical approaches. Mechanical engineers may be involved in the operation of processing plants, or the design of engines, prosthetic devices, steam and gas turbines or compressors and pumps, alternative fuel devices, and many other devices and systems. At Virginia Tech there is a close association between the ME departments research and design project activities with industry. This enhances the opportunities for student interaction with industry representatives.

Mechanical Engineering Program Educational Objectives

Within a few years after graduating from the Mechanical Engineering Department at Virginia Tech, the graduates will attain:

- Positions where they utilize fundamental technical knowledge and skills in mathematics, science, and engineering to analyze and solve problems, and apply these abilities to generate new knowledge, ideas or products in academia, industry or government.
- Practical experience and organizational skills, enabling them to interact and communicate effectively

(written and/or oral) with others (e.g., supervisor, client and/or team) with regard to the diversity of the stakeholders involved in their work.
- Roles of increasing responsibility leading to leadership positions that benefit themselves, their employers and society.
- Skills in life-long learning through: (a) self-study, (b) continuing education/short courses or workshops, and/or (c) formal graduate level education, as well as skills to motivate and encourage co-workers to also pursue lifelong learning.
- Roles in professional and personal life where they demonstrate professional and ethical responsibilities toward peers, employers, and society and follow these precepts in their daily lives.

Program Outcomes

We expect our students to have the following skills, knowledge, and behaviors by the time of their graduation. We want our students to obtain:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.
- An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

The Bachelor of Science in Mechanical Engineering (BSME) degree program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

The department is committed to providing students with an exceptional experience in both the theory and practice of mechanical engineering. In the senior capstone sequence students are required to apply classroom knowledge to complex engineering problems requiring teamwork, problem formulation, economic analysis, effective communication, and product realization. These projects are carefully selected and updated to ensure relevancy to contemporary technical issues and needs. The department encourages the involvement of underclassmen and students outside the department and college in these projects. The department also encourages hands-on student involvement by providing dedicated machine and welding shops that exclusively serve the undergraduate program. The required sophomore-level Manufacturing Processes Laboratory course and certification by a professional machinist are required prior to use of either of these shops. Opportunity for professional development is provided by participation in student professional organizations, such as the American Society of Mechanical Engineers, ASME, and the American Nuclear Society, ANS.

The Curriculum

A total of 131 semester credits are required for graduation. Please refer to the **Registrar's website** for official program checksheets showing the graduation requirements and recommended course plans. A revised ME curriculum is currently in preparation. Students should check the ME website or speak with one of the ME undergraduate advisers for the latest information regarding the proposed curriculum changes. For the currently approved curriculum unofficial documents are available on the ME website showing prerequisite relationships to courses and alternative course plans (e.g. for co-op students and military 4.5 and 5-year plans).

www.me.vt.edu/academic-programs/undergraduate-program/current-students/course-selection/#requiredcourses

The ME curriculum provides a strong foundation in the basic physical and chemical sciences and in mathematics. These are followed by a sequence of courses that provide a broad background in design methodology, computer programming, electronics, solid and fluid mechanics, manufacturing processes, system modeling, machine design, thermodynamics, heat and mass transfer, statistics and materials. Courses in English and in the humanities and social sciences are included to broaden the individual. This background is strengthened and unified through a sequence of engineering design and laboratory courses. Instructional laboratories in the junior and senior years provide opportunities for students to learn measurement and instrumentation techniques. Students apply these skills to the acquisition and analysis of data from various engineering systems.

In all professional endeavors the mechanical engineer must consider ecological effects as well as the economic and social needs of people. The mechanical engineer must consider the conservation of natural resources and the environmental impact in the design of systems. These considerations are included in a number of ME courses and technical elective classes. Students wishing to further strengthen this area may wish to consider the Green Engineering Option at **www.eng.vt.edu/green/index.php**.

The unifying activity in all aspects of mechanical engineering is the design function. A special emphasis has been placed on the use of computer-aided design methods and applied design project experience as a required part of the curriculum. Elective courses in the junior and senior years provide students with the opportunity to pursue specialized interests related to career plans or preparation for graduate study.

The department participates in the Cooperative Education Program in which qualified students may alternate semesters of study with semesters of professional employment. Approximately twenty percent of all mechanical engineering students participate in this program.

Education Abroad Programs

The Department of Mechanical Engineering is a world leader in providing high-quality education abroad opportunities to its students and preparing them to function effectively as true global engineers. The cornerstone of this strategy is the Ultimate Global Engineer Program, which identifies three major windows of opportunity for students to attend topflight mechanical engineering programs abroad and graduate on time. Students can select to participate in any combination of one, two, or even all three of these windows of opportunity:

Windows #1: Fall semester sophomore year in a country where the language of instruction is English. Currently students can attend the University of Melbourne, the top-ranked mechanical engineering program in Australia.

Windows #2: Rising junior summer in a country with a non-English language but where the language of instruction is English. Currently students can attend Shanghai Jiao Tong University, the top-ranked mechanical engineering program in China. This program is particularly well suited for students that need to catch up on their course work, reduce their junior-year course load, or get ahead on their course work.

Windows #3: Senior year abroad in a country with a non-English language but where the language of instruction is non-English. Currently students can attend the Technische Universität Darmstadt (TUD), the top-ranked mechanical engineering program in Germany. Language training is integrated into the curriculum, starting as late as spring semester junior year.

For more information about these and other exiting education abroad programs offered by the Department of Mechanical Engineering, please visit:
http://www.me.vt.edu/international
http://www.tud.vt.edu/BS

Entrance Requirement

The College of Engineering at Virginia Tech limits the number of students who may transfer into any particular department, with that number based upon the number of faculty in each separate department. Refer to the Engineering Education website at **www.enge.vt.edu** for the latest information on transferring into the ME department. The ME academic advisor may also be consulted for information on anticipated entrance requirement changes.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Curriculum for Liberal Education (recently replaced with Pathways General Education Curriculum), and toward the degree in mechanical engineering.

Satisfactory progress toward a B.S. in Mechanical Engineering includes the following minimum criteria:

- Complete a minimum of 12 credits that apply toward the BSME each year
- maintain an in-major GPA (all ME and NSEG courses) of at least a 2.0
- maintain an extended in-major GPA of at least 2.0 (in all ME, NSEG courses plus ESM 2104, 2204, and 2304).
- complete ESM 2104, Math 2114 and Math 2204 within 45 attempted required course credits (not to include CLE courses, technical electives or free electives)
- complete ESM 2304, ME 2124, and Math 2214 within 60 attempted required course credits (not to include CLE courses, technical electives, or free electives)
- complete ME 3124, ME 3514 and ME 3614 within 72 attempted required course credits (not to include CLE courses, technical electives, or free electives)
- complete ME 4006, ME 4015 and ME 4124 within 90 attempted required course credits (not to include CLE courses, technical electives, or free electives)
- complete any required course in the ME curriculum within two or feer attempts

The department offers graduate programs leading to the M.S., M.Eng., and Ph.D. in mechanical engineering (see the **Graduate Catalog**).

The Department of Mechanical Engineering actively seeks input on the nature and quality of our program from all interested individuals and organizations, including students, employers and supporting agencies. Our goal is to provide the best possible service to the students who entrust their education to us. Through our continuous improvement efforts, we pledge to continually improve the content of our curriculum, our educational methods and our facilities. Comments to the department head or any member of the faculty are welcomed. Note that because of this continuous improvement process entrance and degree requirements and course content are subject to change. Please consult the department academic advisor for current information.

Undergraduate Course Descriptions (ME)

2004 (MATH 2004): ENGINEERING ANALYSIS USING NUMERICAL METHODS
Numerical methods applied to engineering analysis. Numerical techniques including root finding, linear algebra, integration, ordinary differential equations, curve fitting, discrete Fourier transforms, optimization. Structured programming and iterative problem-solving using a high-level environment such as Matlab. Pre: (ENGE 1216 or ENGE 1414), MATH 1226, (MATH 2114 or MATH 2114H or MATH 2405H or MATH 2214). (2H,3L,3C)

2024: INTRODUCTION TO ENGINEERING DESIGN AND ECONOMICS
Design process, mini-design projects, collaborative design, product dissection, economics of decision making, reverse engineering, intellectual property, oral, written, and graphic communications, engineering ethics. Pre: (ENGE 1216 or ENGE 1114 or ENGE 1434 or ENGE 1414). Co: ESM 2104, MATH 2114, PHYS 2306. (3H,3C)

2124: INTRODUCTION TO THERMAL AND FLUID ENGINEERING
Basics of thermodynamics, fluid mechanics, and heat transfer. Fluid and thermal properties of materials. Ideal

gas equation of state. First law of thermodynamics in closed systems. Transient heat transfer. First law of thermodynamics in open systems. Fluid mechanics balances, open systems. Emphasis on applications in all topic areas. Pre: (ESM 2104 or PHYS 2306), (MATH 2114 or MATH 2114H). Co: MATH 2214. (2H,2C)

2134: THERMODYNAMICS
Classical (equilibrium) thermodynamics and its applications. Includes thermodynamic properties of pure substances: property diagrams, property tables, property software, equations of state; the first law of thermodynamics; the second law of thermodynamics; gas mixtures; combustion: atomic and energy balances; and power and refrigeration cycles. Pre: PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2406H), CHEM 1035. Co: MATH 2214. (4H,4C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Variable credit course.

3024: ENGINEERING DESIGN AND ECONOMICS
Engineering design process; project management; product planning; customer needs, specifications, and Quality Function Deployment (QFD); benchmarking and intellectual property; concept generation, screening, scoring, and selection; design for assembly, product architecture, economic, and ethical considerations; concept testing. Written and oral communications of engineering design; computer aided design. Team-based term project with prototype fabrication of mechanical assembly manipulated by a microcontroller. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016. Pre: 2004, MSE 2034, ESM 2204, ENGL 1106. Co: 3624. (3H,3C)

3034: MECHANICAL ENGINEERING DISCOURSE
Principles and application of effective technical and professional communication in mechanical engineering; organizing, structuring, and developing effective written documents and oral presentations for a range of audiences, including technical reports, memorandums, laboratory reports, live and recorded presentations, and posters for public exhibition; use of effective language and style; development of effective visual aids; presentation delivery skills; acquiring new knowledge using appropriate learning strategies by finding, comprehending and evaluating information from a variety of sources; ethical and professional responsibilities in both identifying appropriate information and communicating technical results. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016. Pre: 3024. Co: 4005. (1H,1C)

3124: THERMODYNAMICS
Classical thermodynamics and its applications. Thermodynamic properties of pure substances: property tables, property software, equations of state. First law of thermodynamics. Second law of thermodynamics. Gas mixtures. Combustion: atom and energy balances. Power and refrigeration cycles. Pre: (2124, MATH 2214, MATH 2204) or (ME 2124, MATH 2214, MATH 2204H) or (ME 2124, MATH 2214, MATH 2224) or (ME 2124, MATH 2214, MATH 2224H) or (ME 2124, MATH 2214H, MATH 2204) or (ME 2124, MATH 2214H, MATH 2204H) or (ME 2124, MATH 2214H, MATH 2224) or (ME 2124, MATH 2214H, MATH 2224H) or (ME 2124, MATH 2405H, MATH 2406H). (3H,3C)

3134: FUNDAMENTALS OF THERMODYNAMICS
Fundamental concepts, first and second laws, gas and vapor processes with emphasis on chemical reactions, statistical interpretation of entropy, limited use of thermodynamic property tables. This course is for non-ME students. Pre: MATH 2214 or MATH 2214H. (3H,3C)

3304: HEAT AND MASS TRANSFER
Comprehensive basic course in heat and mass transfer for mechanical engineering students. Principles of conduction, convection, and radiation with applications to heat exchangers and other engineering systems. Pre: (2124 or 2134), (MATH 2214 or MATH 2214H or MATH 2306H), (MATH 2204 or MATH 2204H or MATH 2406H). (3H,3C)

3404: FLUID MECHANICS
Comprehensive first course in basic and applied fluid mechanics. Fluid properties, statics, kinematics, and dynamics. Euler's and Bernoulli's equations. Hydrodynamics. Dimensional analysis and similitude. Real fluids, laminar and turbulent flows. Boundary layer model and approximate analysis. Compressible flow and propulsion devices. Flow measurement. Introduction to turbomachinery with applications. Pre: (2124, MATH 2214, MATH 2204) or (ME 2124, MATH 2214, MATH 2204H) or (ME 2124, MATH 2214, MATH 2224) or (ME 2124, MATH 2214, MATH 2224H) or (ME 2124, MATH 2214H, MATH 2204) or (ME 2124, MATH 2214H, MATH 2204H) or (ME 2124, MATH 2214H, MATH 2224) or (M E 2124, MATH 2214H, MATH 2224H) or (ME 2124, MATH 2405H, MATH 2406H). (3H,3C)

3414: FLUID DYNAMICS
Comprehensive first course in fluid dynamics. Fluid properties. Hydrostatics. Mass, momentum,and energy conservation in control volumes. Elementary dynamics and Bernoulli's equation.Dimensional analysis and similitude. Laminar and turbulent flows. Introduction to Euler's and Navier-Stokes equations. Pipe flows. External flows and boundary layers. Introduction to compressible flows. Includes laboratory experiments. Pre: 2004, MATH 2114, MATH 2204, MATH 2214. Co: 2134. (3H,3L,4C)

3504: DYNAMIC SYSTEMS - VIBRATIONS
Principles of dynamic system modeling with emphasis on second order mechanical systems. Harmonic and nonharmonic vibrations of single and multi-degree of freedom systems. Applications of computer simulation and analysis techniques in vibrations. Pre: (3514, MATH 2214) or (ME 3514, MATH 2214H) or (ME 3514, MATH 2405H, MATH 2406H). (3H,3C)

3514: SYSTEM DYNAMICS
Mathematical descriptions of physical systems' behavior including mechanical, electrical, thermal, and fluid systems and their combinations; system descriptions using state variable and transfer functions; analysis of system responses: convolution integral, frequency response, numerical simulations, and Laplace transform methods; systems concepts: input-output, causality, and analogies; general process descriptions including first-order, second-order, and time delayed. Pre: (ESM 2104, ESM 2304, MATH 2214, MATH 2204, MATH 2114) or (ESM 2104, ESM 2304, MA TH 2214, MATH 2204, MATH 2114H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2204, MATH 24 05H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2204H, MATH 2114) or (ESM 2104, ESM 2304 , MATH 2214, MATH 2204H, MATH 2114H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2204H, M ATH 2405H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2224, MATH 2114) or (ESM 2104, ESM 2304, MATH 2214, MATH 2224, MATH 2114H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2224 , MATH 2405H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2224H, MATH 2114) or (ESM 2104, ESM 2304, MATH 2214, MATH 2224H, MATH 2114H) or (ESM 2104, ESM 2304, MATH 2214, MATH 2224H, MATH 2405H) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2204, MATH 2114) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2204, MATH 2114H) or (ESM 2104, ESM 2304, MATH 2214 H, MATH 2204, MATH 2405H) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2204H, MATH 2114) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2204H, MATH 2114H) or (ESM 2104, ESM 2304, M ATH 2214H, MATH 2204H, MATH 2405H) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2224, MAT H 2114) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2224, MATH 2114H) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2224, MATH 2405H) or (ESM 2104, ESM 2304, MATH 2214H, MATH 222 4H, MATH 2114) or (ESM 2104, ESM 2304, MATH 2214H, MATH 2224H, MATH 2114H) or (ESM 21 04, ESM 2304, MATH 2214H, MATH 2224H, MATH 2405H) or (ESM 2104, ESM 2304, MATH 2405H, MATH 2406H). (3H,3C)

3524: MECHANICAL VIBRATIONS
Development and application of mathematical methods, physical understanding, and computational tools for modeling, analysis, and design of vibrating systems. Free and forced vibration of single and multiple degree-of-freedom systems, particularly systems experiencing sinusoidal excitation. Distributed parameter systems. Practical engineering applications. Pre: ESM 2304, (MATH 2114 or MATH 2114H or MATH 2405H), (MATH

2214 or MATH 2214H or M ATH 2406H), ME 2004. (4H,4C)

3534: CONTROLS ENGINEERING I
Fundamentals of feedback control theory, time-domain and frequency-domain analysis, automatic control system design synthesis to meet performance and stability requirements, numerical simulation and discrete real-time implementation on microcontrollers. Pre: 2004, MATH 2114, MATH 2204, ESM 2104, ESM 2304. (3H,3L,4C)

3604: KINEMATICS AND DYNAMICS OF MACHINERY
Kinematic analysis and design of cams, gears, and linkages, velocity, acceleration and force analysis, kinematic synthesis, balancing, kinematic and force analysis by complex numbers, computer-aided analysis, and synthesis of linkages. Pre: ESM 2304. (3H,3C)

3614: MECHANICAL DESIGN I
Design of mechanical components subject to static and fatigue loads. Design using screws, fasteners, springs and bearings. Computer-aided design using transfer matrix and finite element methods. Pre: ESM 2204, (MATH 2214 or MATH 2214H), (MATH 2114 or MATH 2114H). (3H,3C)

3624: MECHANICAL DESIGN
Comprehensive first course in mechanical design. Stress and Strain. Fundamentals of designing mechanical components subjected to static and cyclical loads. Design elements for screws, fasteners, springs, and welds. Hands-on laboratory learning of concepts discussed in class. Course credit will not be awarded for both ME 3614 and ME 3624. Pre: 2004, ESM 2204, MATH 2214. (3H,3L,4C)

3984: SPECIAL STUDY
Variable credit course.

4005-4006: MECHANICAL ENGINEERING LAB
Principles of measurement, measurement standards and accuracy, detectors and transducers, digital data acquisition principles, signal conditioning systems and readout devices statistical concepts in measurement, experimental investigation of engineering systems, technical report writing. Pre: (STAT 3704 or STAT 4604 or STAT 4705 or STAT 4714), (ME 3514 or ME 3524), (ECE 2054 or ECE 3054) or (ECE 2004, ECE 2074) for 4005; 4005, ECE 3254 for 4006. Co: ECE 3254 for 4005. (2H,3L,3C)

4015-4016: ENGINEERING DESIGN AND PROJECT
Team oriented, open-ended, multi-disciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product realization and testing. Emphasis on documenting and reporting technical work. Making informed judgments which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. 4015: Problem identification, including consideration of public health and welfare, as well as global, cultural, social, environmental, and economic factors and constraints; idea generation and concept selection; application of design, test, and analysis tools developed in previous courses; ethical and professional responsibilities; verification and validation; communication and working in teams. 4016: Project management; working on teams, analysis and optimization, fabrication and testing, and communicating technical ideas. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016. Pre: 4005, (2024 or 3034), ECE 3254, (ME 3614 or ME 3624), ME 3304, (ME 3504 or ME 45 04) or (ME 3524, ME 3534) for 4015; 4015 for 4016. (2H,3L,3C)

4034: BIO-INSPIRED TECHNOLOGY
Introduction to engineering solutions inspired by biological systems. Overview over the approach of bio-inspired technology and the state of the art. Exploration of the relationship between engineered and natural biological systems. Explanation of concepts of biological systems, such as evolutionary optimization, sensing, actuation, control, system integration, assembly and materials in engineering terms. Practice of interdisciplinary analysis skills in technical report writing projects where man-made and biological systems are evaluated for parallels to engineering and their technological potential. Pre: (PHYS 2205, PHYS 2206) or (PHYS 2305, PHYS 2306). (3H,3C)

4124: COMPUTER AIDED DESIGN OF FLUID-THERMAL SYSTEMS

Review of physical laws and engineering concepts introduced in thermodynamics, fluid mechanics, and heat transfer with applications. Emphasis on analysis, modeling, and design of engineering systems, components, and physical phenomena with state-of-the-art computer software such as Ansys CFX, Star CCM, Aspen Plus, and ProSimPlus. Pre: (3124 or 2134), (3404 or 3414), 3304. (2H,2L,3C)

4154: INDUSTRIAL ENERGY SYSTEMS
Survey of energy-intensive technologies used in typical industrial plants, with emphasis on cost-effective energy conservation. Burners, boilers, pumps, air compressors, electric motors, lights, refrigeration plants, HVAC systems, cogeneration systems, waste heat recovery equipment. Energy-efficient design and operation. Determination of energy efficiency based on field measurements. Economic analysis of energy conservation measures. Mitigation of environmental impacts. Pre: 3114 or 3124 or 3134 or CHE 2164 or BSE 3154. (3H,3C)

4164: ENERGY SYSTEMS FOR BUILDINGS
Application of the fundamental principles of thermodynamics, heat transfer, and fluid flow to analyze energy use for building environmental control. Exploration of approaches for configuring basic thermal-fluid engineering components (e.g. pumps, piping, fans, heat exchangers, refrigeration cycles, etc.) to yield systems that provide heating, cooling, and ventilation. Introduction to techniques and software tools for estimating energy use by these systems and the associated economic and environment impact. Examination of alternate technologies for meeting building energy needs including small scale combined heat and power systems and renewable energy systems. Pre: 2124, 3124. (3H,3C)

4174 (AOE 4174): SPACECRAFT PROPULSION
Spacecraft propulsion systems and their applications in orbital, interplanetary, and interstellar flight. Rocket propulsion fundamentals; advanced mission analysis; physics and engineering of chemical rockets, electrical thrusters, and propellantless systems (tethers and sails); spacecraft integration issues. Pre: 4234 or AOE 4234. (3H,3C)

4194 (ESM 4194): SUSTAINABLE ENERGY SOLUTIONS FOR A GLOBAL SOCIETY
Addresses energy metrics, global and US energy supply and demand, transitional energy sources (natural gas, petroleum, coal, nuclear), sustainable/renewable source (solar, geothermal, hydro, tidal, wind, biofuels), and methods for increasing efficiencies (energy storage, batteries, green building, conservation). Options for transportation, electricity, lighting and heating needs of industry, agriculture, community, and citizens. Production, transmission, storage, and disposal issues considered in the context of global political, economic, and environmental impacts. Senior Standing in major may be substituted for pre-requisite ENGL 3764. Pre: (CHEM 1035 or CHEM 1055), PHYS 2306, ENGL 3764. (3H,3C)

4204: INTERNAL COMBUSTION ENGINES
Analysis and design of gasoline and diesel engines. Fundamental processes and their application in current technology. Thermodynamics: air standard and air-fuel cycles. Combustion: stoichiometry, fuels, chemical equilibrium, chemical kinetics, flame propagation, knock, pollutant formation and control. Flow processes: volumetric efficiency, intake and exhaust tuning, two-stroke scavenging, carburetion, fuel injection, super- and turbo-charging. Pre: 3124, 3404. (3H,3C)

4224: AIRCRAFT ENGINES AND GAS TURBINES
Performance and characteristics of aircraft engines and industrial gas turbines, as determined by thermodynamic, fluid mechanic, heat transfer, and solid mechanic behavior of components. Operational limitations and component matching. Stress and associated temperature limits and influence of blade cooling techniques on turbines. Pre: 4234 or 4124. (3H,3C)

4234 (AOE 4234): AEROSPACE PROPULSION SYSTEMS
Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements. Must have a C- or better in pre-requisites ME 3404 and ME 3124 or AOE 3114 and AOE 3134. Pre: (3404, 3124) or (AOE 3114, ME 3134). (3H,3C)

4324: ENERGY SYSTEMS: THEORY AND APPLICATIONS

Theory and applications of thermodynamic and fluid mechanics principles as applied to energy systems. Fundamental concepts on exergy, mixtures, psychrometry and thermochemistry. Analyses and applications include vapor and gas power systems, refrigeration, air conditioning, combustion processes and one-dimensional compressible flow. Pre: 3124, 3404. (3H,3C)

4344 (CHE 4304): BIOLOGICAL TRANSPORT PHENOMENA
Engineering analysis and predictive modeling of heat and mass transport in biological systems (e.g., tissues, organs, organisms, and biomedical devices). Examination of processes that involve conduction, convection, diffusion, generation/consumption. Application of analytical and computational methods to solve differential equations that describe unsteady and/or multi-dimensional transport. Topics include oxygen transport, pharmacokinetic analysis, kidney function, blood perfusion, burns, and cryopreservation. Pre: (CHE 3114, CHE 3044, CHE 3144) or (ME 3304, ME 3404) or (CHE 3114, CHE 3044, CHE 3144) or (ME 3304, ME 3404). (3H,3C)

4454 (EDCI 4454): ENGINEERING LEADERSHIP IN PRACTICE: MANAGING THE TECHNICAL DESIGN PROCESS
Introduction to management and mentoring skills associated with the application of the engineering design process. Course covers skills necessary for leading diverse teams of people through a technical design project. Managing teams of local high school students through an authentic technical design experience associated with design competitions. Course addresses the practical applications of science, math and engineering, while building and managing teams of people to meet technical project goals. Prerequisite: ME 4015 or similar team-based design experience, or by permission of instructor. Pre: 4015. (2H,3L,3C)

4504: DYNAMIC SYSTEMS - CONTROLS ENGINEERING I
Fundamentals of feedback control theory, classical analysis and design techniques for automatic controls, introduction to modern control theory. Pre: (3514, MATH 2214) or (ME 3514, MATH 2214H) or (ME 3514, MATH 2405H, MATH 2406H). (3H,3C)

4524: INTRODUCTION TO ROBOTICS AND AUTOMATION
Automation, robot technology, kinematics, dynamics, trajectory planning, and control of two-dimensional and spatial robots; robot programming; design and simulation of robotic devices. Pre: (ECE 2574, STAT 4714) or (ME 3514, STAT 3704). Co: 4584. (3H,3C)

4534: LAND VEHICLE DYNAMICS
Analytical methods for land vehicle dynamics. Mechanics of pneumatic tires on pavement and steel wheels on rails. Vehicle stability, handling, response to random guideway and roadway irregularities, ride quality computation methods and standards, suspension design. Pre: 3514. (3H,3C)

4544: AUTOMOTIVE ENGINEERING
Vehicle performance, drive train, suspension, steering, and brake systems. Steady state and transient conditions. Senior standing in Mechanical Engineering required. (3H,3C)

4554: ADVANCED TECHNOLOGY FOR MOTOR VEHICLES
Energy use and environmental issues for motor vehicles: Emissions standards, fleet requirements, dynamometer testing, fuel economy, and vehicle performance. Alternative fuel vehicles: Characteristics and infrastructure of fuels, batteries, electric vehicles, and hybrid electric vehicles. Vehicle design: Modeling and simulation of vehicle energy use and performance, component sizing. Fuel cells for transportation. Heavy-duty vehicles and busses. Low mass vehicles and future vehicle technology. Pre: 3114 or 3124 or 3134. (3H,3C)

4564: VEHICLE CONTROL
Overview of vehicle control systems and control algorithms for anti-lock braking, stability, road holding, lane departure, traction control, and tire pressure monitoring. Advanced driver assist systems and intelligent tire technology. Hands-on experience with hardware-in-the- loop systems. Mathematical modeling and simulation of vehicle control. Pre: 4504 or 3504. (3H,3C)

4584 (ECE 4584): ROBOTICS LABORATORY
Develop, compile, and test algorithms for serial and mobile robots. Robot forward and inverse kinematics, task planning, velocity kinematics, force rendering, control, haptics, mapping and localization, computer vision and

path planning. Co: ME 4524 or ECE 4704 (3L,1C)

4614: MECHANICAL DESIGN II
Design of mechanical elements such as welded joints hydrodynamic bearings, spur gears, shafts, brakes. Alternative fatigue design methods, cumulative fatigue, mechanical design computer software. Pre: 3614. (3H,3C)

4624: FINITE ELEMENT PRACTICE IN MECHANICAL DESIGN
Application of the finite element method to stress analysis problems in mechanical design. Modeling techniques, proper use of existing computer programs, interpreting of results, application to design modification. Pre: 3614. (3H,3C)

4634: INTRODUCTION TO COMPUTER-AIDED DESIGN AND MANUFACTURING
Participants will study the computer-aided design and manufacturing of mechanical systems. A mechanical system will be designed including preliminary design, analysis, detail design, numerical control programming, and documentation. Applications programs will be written and interfaced to the CAD/CAM database. All assignments will be carried out on a CAD/CAM system. (2H,3L,3C)

4644: INTRODUCTION TO RAPID PROTOTYPING
Participants will study topics fundamental to rapid prototyping and automated fabrication, including the generation of suitable CAD models, current rapid prototyping fabrication technologies, their underlying material science, the use of secondary processing, and the impact of these technologies on society. The rapid prototyping process will be illustrated by the actual design and fabrication of a part. Programming skills required. (3H,3C)

4664: INTRODUCTION TO GLOBAL COLLEGIATE ENGINEERING DESIGN
Participants will study topics fundamental to global collaborative engineering design, product data management, and collaborative product data management. These topics will be applied during a team project with team members located overseas, utilizing state-of-the-art collaborative engineering and product data management software and hardware technologies. Partially duplicates 5664. Credit may only be received for one course. Pre: 2024. (3H,3C)

4724: ENGINEERING ACOUSTICS
Basic acoustical theory and practice, acoustic terminology, measurement, transmission, and perception of sound, muffler design, noise control techniques. Pre: 3514. (3H,3C)

4735,4736: MECHATRONICS
Electromechanical system modeling, control and applications. Design and building of electronic interfaces and controllers for mechanical devices, sensors, signal acquisition, filtering, and conditioning. Microcontroller-based closed-loop control and device communications. Sensor and actuator selection, installation, and application strategies are studied. A term design project is a key component to this course (for 4736). Pre: (ECE 3254, ME 3514) or (ECE 2004, ECE 2704) for 4735; 4735 for 4736. (3H,3C)

4764: AUDIO ENGINEERING TECHNOLOGY
Principles and design in the field of audio engineering. Loudspeaker design and construction, microphone technology, digital audio acquisition, signal processing in audio engineering, human perception, technical acoustics, binuaral hearing, surround sound processing and production, theory, measurement, and reproduction of 3D surround sound, virtual instrument theory and practice, room acoustics and simulation, principles of audio effects (e.g., compression, reverberation, equalization), and acoustic materials engineering. Pre: 3504 or 4504. (3H,3C)

4854: NANO AND MICROMECHANICS OF MATERIALS
Analysis of microstructural mechanics, crystal structures, defects, and dislocations. Mechanical behavior of crystalline materials at the microscale. Computational modeling of mechanical behavior in discrete atomistic and molecular systems, including molecular dynamics. Application of these methods to polymers and other soft materials, biological materials, carbon-based materials, and metallic alloys. Pre: ESM 2204. (3H,3C)

4864: MICRO/NANO-ROBOTICS
Overview of Micro/Nano-robotic systems. Physics of reduced length scales (scaling effects in the physical

parameters, surface forces, contact mechanics, and Micro/Nano-scale dynamical phenomena), Basics of Micro/Nano-manufacturing, microfabrication and soft lithography, Biomimetic design strategies for mobile micro-robots, Principle of transduction, material properties and characteristics of Micro/Nano-actuators (piezoelectric, shape-memory alloy, and a variety of MEMS and polymer actuators), Control requirements and challenges of Micro/Nano-actuators, Micro/Nano sensors for mobile microrobotic applications, Micro/Nano-manipulation (scanning probe microscopy, operation principles, designing experiments for nanoscale mechanical characterization of desired samples). Pre: MATH 2214, ME 3404, ME 3514, ESM 2204. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (NSEG)

3145-3146: FUNDAMENTALS OF NUCLEAR ENGR
Application of fundamental principles of neutron physics and reactor theory. Introduction to nuclear cross-section data, neutron scattering, nuclear fission, and diffusion theory. Examination of current and next generation nuclear power. Pre: MATH 2214 or MATH 2214H for 3145; 3145 or ME 3145 for 3146. (3H,3C)

3604: RADIATION DETECTION, PROTECTION AND SHIELDING
Radioactive decay, interaction of charged particles and photons with matter, methods of radiation detection and radiation dosimetry, counting statistics, radiation protection criteria and exposure limits, external radiation protection using time, distance and shielding. Pre: PHYS 2306. Co: MATH 2214. (3H,3C)

4204: NUCLEAR FUEL CYCLE
Uranium nuclear fuel cycle: radiation basics, uranium reserves, mining, conversion, enrichment, fuel manufacturing, in-core fuel management and refueling, spent fuel storage, reprocessing/recycling and final disposition as waste in a geologic repository. Introduction to nuclear safeguards and nonproliferation as applied to each step of cycle. Alternative fuel cycles. Co: 3146. (3H,3C)

4214: NUCLEAR POWER PLANT OPERATIONS
Emphasis on pressurized water reactor plant operations. Review of boiling water reactor operations. Detailed system functions and operation, reactor plant startup and shutdown procedures, reactor refueling, reactor plant safety analysis, reactor plant licensing, ethics and integrity in the nuclear industry. Pre: 3146. (3H,3C)

4424: REACTOR THERMAL HYDRAULICS
Fundamental processes of heat generation and transport in nuclear reactors: reactor coolant systems and components, heat generation and spatial distribution, heat transport by conduction and convection, single-phase flow, two-phase flow and boiling, critical heat flux. Pre: 3145. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH

Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors Section Variable credit course.

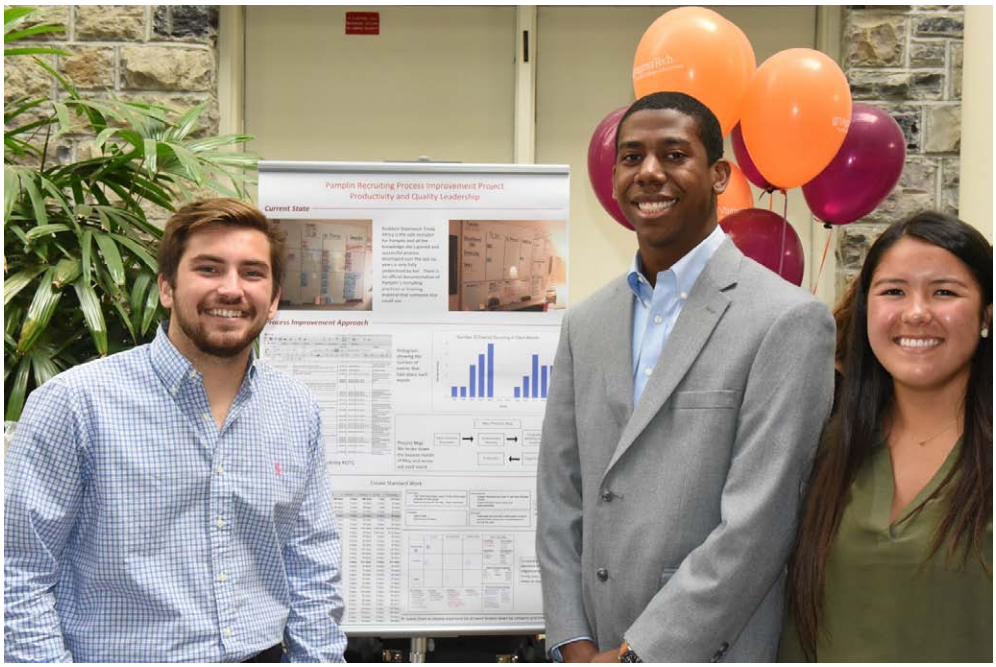
Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Management

Head: Devi R. Gnyawali
Digges Professor of Entrepreneurship: S. E. Markham
Pamplin Professors of Management: D. R. Gnyawali and R. E. Wokutch
Associate Professors: J. B. Arthur, D. J. Beal, W. J. Becker, D. E. Hatfield, and R. D. Zimmerman
Assistant Professors: K. S. Awate, R. A. Hunt, A. Kemp, P. Kumar, M. Stallkamp, P.S. Thompson, D. M. Townsend, and A. K. Ward Bartlett
Collegiate Assistant Professor: J. J. Simpson
Professor of Practice: S. J. Skripak
Professor of Practice in Entrepreneurship: M. B. Mondry
Associate Professor of Practice: R. B. Kennedy
Assistant Professor of Practice: D. E. Bluey, D. R. Buengel, K. A. Carlson, and E. Jamison
Instructors: A. H. Cortes and M. Deck
Affiliated Faculty: M. Singal, D. Stone, and E. Stone-Romero
Emeritus Faculty: L. D. Alexander, T. W. Bonham, A. T. Cobb, J. L. French, J. R. Lang, R. M. Madigan, K. F. Murrmann, J. F. Robinson, J. M. Shepard, W. J. Smith, and C. U. Stephens
Career Advisor: D. E. Bluey
Business Leadership Center Director: K. A. Carlson
Integrated Security Education and Research Center Director: J. J. Simpson

Web: **www.management.pamplin.vt.edu**



Overview

Students in the Management major are guided by world-class faculty to prepare for careers in industry-leading and highly successful organizations. Our courses build strong foundations in fundamental management processes and prepare students to drive and lead organizations to sustainable and profitable growth in an increasingly complex world. We equip students with the mindset, approaches, and tools to succeed in a global business environment and the ability to translate disruptive change into business opportunities. Our courses and curriculum emphasize critical thinking, innovative problem solving, data analytics, ethical reasoning, persuasive communication, diversity & inclusion, and interpersonal and team effectiveness. These skills position Pamplin Management graduates for future success in a wide variety of high-paying careers or as entrepreneurs. We offer the three options of Entrepreneurship, Innovation & Technology Management (EIT), Human Resource Management (MHR) and Management Consulting & Analytics (MCA) following the Management Department's paradigm to Collaborate - Innovate - Integrate.

Management majors add considerable value to the organizations that employ them. Great managers in any business act as force multipliers, increasing the output generated by the people they work with and the resources available to them. Management majors, their teams and their organizations do this by finding ways to help organizations work smarter. Our core curriculum helps students develop the awareness needed to identify new entrepreneurial opportunities, improve organizational processes, use analytics to support evidence-based decisions, and effectively manage projects in support of organizational change and improvement.

Management majors complete at least one of three career-centered options: Entrepreneurship, Innovation and Technology (EIT), Managing Human Resources (MHR), or Managing Consulting and Analytics (MCA). In addition, many students choose to minor in Entrepreneurship, Leadership or International Business. Students also participate in paid and for-credit internships, career-focused clubs and student-led extracurricular activities. An emphasis on developing employable skills is further supported by course-based and one-on-one career planning.

Degree Requirements

The graduation requirements in effect at the time of graduation apply to the awarding of degrees. When consulting the degree requirements information, the year of expected graduation needs to be chosen. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Management Options

Each Management major is required to select and complete at least one 9 credit hour management option. These options are designed to provide students critical skills targeted toward potential future career paths in the following areas.

Option EIT: Entrepreneurship, Innovation & Technology Management

Students develop an entrepreneurial mindset and the related organizational skills to identify problems that can be converted into opportunities, attract and deploy resources in pursuit of those opportunities, and to lead through innovation in both new and established companies. This option is designed for students who are considering starting their own businesses or who want to play a key role in making existing businesses more innovative and entrepreneurial. Three additional courses are required for those students selecting this option.

Option MHR: Human Resource Management

This option prepares general managers or individuals interested in a career in the human resources field with the knowledge and skills necessary to systematically manage people to achieve group and organizational objectives and to sustain organizational effectiveness. Students will be able to use systems in areas such as HR strategy, recruitment, training & development, performance management, corporate culture, change management, diversity & inclusion and compensation & benefits. This option will not only prepare students for functional careers in Human Resource Management but will also equip future business managers and leaders with the mindsets and tools to manage human assets successfully. Three additional courses are required for those students selecting this option.

Option MCA: Management Consulting & Analytics

Students develop knowledge and analytical skills to break down complex strategic problems and develop robust and innovative solutions, enabling them to pursue careers in management consulting. Critical skills and competencies taught in this option will also benefit future managers and leaders to drive success in a complex environment that relies heavily on data, analytics, project management and the power of high-performing teams. Three additional courses are required for those students selecting this option.

Minors Offered Through the Department of Management

Students from majors across the university (including Management majors) may also earn any of two minors offered through the Department of Management. These minors are the Organizational Leadership minor and the Entrepreneurship - New Venture Growth minor.

Organizational Leadership Minor

The Pathways Minor in Organizational Leadership is open to all Virginia Tech students with at least a 2.5 GPA in a minimum of 24 hours at Virginia Tech. The curriculum provides students with courses and experiences necessary to serve as more effective leaders within their organizations. Each student takes courses to improve their competencies across four areas: creativity and innovation; critical and strategic thinking; intercultural communication; and holistic thinking and ethical reasoning. Students also participate in a leadership field experience which enables them to develop areas specific to their own needs. The leadership minor consists for eighteen hours of study, including six hours of management courses, nine hours of electives, and three hours of experiential activity. Nine of the hours also count toward a student's Pathways to General Education requirements.

Entrepreneurship - New Venture Growth Minor

The Entrepreneurship-New Venture Growth minor is intended to focus on the knowledge and skills to create new ventures and lead their early growth. The objective is to provide students with the knowledge and skills needed to convert ideas into business successes, particularly in the context of engineering and science-based technology commercialization.

The curriculum consists of eighteen credit hours of study, including six hours of business restricted electives, and six hours of restricted electives.

Undergraduate Course Descriptions (MGT)

1064: ENTREPRENEURS RESIDENCE EXPERIENCE
Introduces students in the Innovate Living Learning Community to the various aspects of the entrepreneurial ecosytem at Virginia Tech and familiarizes them with common business terminology in the field. Discover the difference between ideas and entrepreneurial opportunities and relate current business events to topics in the course, including specific entrepreneurial opportunities. Provides weekly opportunities to interact with and learn from visiting entrepreneurs through various methods (i.e. fireside chats, dinners, and speaking events) to enhance learning outside of the classroom and build confidence in engaging with seasoned professionals. Discusses entrepreneurial ideas and current opportunities and applies learning to create and deliver an effective, individual startup concept pitch. (3H,3C)

1104: FOUNDATIONS OF BUSINESS
Introduces students to the free enterprise system and the various business functions, such as management, human resources, marketing, operations, accounting and finance, technology as well as to the different types of business such as manufacturing and service. Analyzes the various business functions to help improve understanding of career interests and opportunities, as well as to provide a basic understanding of how a company operates. Applies learning through a group project in which a micro-business is created and managed. (3H,3C)

1935-1936: FUNDAMENTALS OF CADET PROFESSIONAL LEADERSHIP
1935: Foundational course of the Virginia Tech Corps of Cadets Citizen-Leader Program. Explores basic business etiquette and introduces the cadet to concepts of online professional identity, basic career preparation, resume writing, basic interviewing techniques and ways to create a healthy nutrition and physical fitness program. Includes a comprehensive physical fitness laboratory. Membership in the Corps of Cadets is required. 1936: Introduces methodologies for efficient and effective leadership, explores options for multiple career paths, basic business etiquette, opportunity to attend leadership conferences and field trips to local businesses. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required. (1H,2L,2C)

1945-1946: FUNDAMENTALS OF CADET LEADERSHIP
Foundational course of the Virginia Tech Corps of Cadet Leader Development Program. Explores self-understanding, personality types, active and passive followership, leadership and ethical theories. A laboratory introduces freshmen cadets to academic success strategies. Membership in the Corps of Cadets is required. (1H,2L,2C)

1984: SPECIAL STUDY
Variable credit course.

2064: FOUNDATIONS OF ENTREPRENEURSHIP
Introduction to the study and practice of entrepreneurship in a human-centered context. Examination of the influence of different cultures, institutions, and global factors and the role of human values, beliefs and behaviors on modes of entrepreneurial action. Application of theories and methods of entrepreneurial opportunity identification within the contexts of human behavior, social institutions and/or patterns of culture to generate ideas for new ventures and application of design-thinking theories and concepts in a field-based, experiential learning project to design, iterate and validate a value proposition and business model for a new

venture. (3H,3C)

2104: CAREERS IN MANAGEMENT
Career opportunities associated with the Management major's three options: Human Resource Management (HRM), Management Consulting and Analytics (MCA), and Entrepreneurship, Innovation and Technology (EIT). Analyzes the current job markets and opportunities for these career paths. Creating effective resumes and cover letters and researching and networking with targeted firms. Experience scenarios of informational, behavioral, case interviews, and elevator pitch presentations. Incorporate real life perspective through guest speakers who are industry experts and local field visits. Sophomore and Junior Management majors and business undecided only, (1H,1C)

2314 (HTM 2314): INTRODUCTION TO INTERNATIONAL BUSINESS
Fundamental concepts of international business. International business environment and how it affects decisions, the creation of competitive advantage in the multinational firm, and complexities of managing it. Why international businesses exist, drivers of international expansion, differences among countries in terms of political, legal, economic, technological and cultural dimensions, and the complexity of international business decisions. Causes and consequences of globalization, international trade, and analyzing the challenges of managing international business, with a focus on a number of industries, including hospitality and tourism. Operational, strategic, and ethical issues which are unique to multinational corporations. (3H,3C)

2354: LEADERSHIP FOR MANAGERS AND ENTREPRENEURS
Explores a broad range of concepts and theories important for a basic understanding of leadership skills for managers and entrepreneurs, including team leadership, motivation, conflict management, and community leadership. Practical assignments and case analyses used to examine the ethical challenges leaders face in a global context. Pre: Sophomore Standing. (3H,3C)

2404 (BIT 2404): MULTICULTURAL PROBLEM SOLVING AND ANALYTICS
Study of how people and organizations in multiple cultures analyze, model and solve problems from a business perspective. Addresses ethical considerations in developing and solving problems. No statistics background is required. Sophomore standing. Pre: MATH 1025, (MATH 1225 or MATH 1525). (3H,3C)

2935-2936: CAREER PLANNING FOR CADETS
2935: Cadets in this class learn the basic of business networking, developing presentations, professional mentorship, personal finance, and investments, advanced nutrition and living a healthy lifestyle. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required. (1H,2L,2C)

2944: MILITARY LEADERSHIP PRACTICUM
Progressive leadership education, training and development through readings, lectures, exercises and leadership positions within the Corps of Cadets. Emphasis of this course is on the day-to-day implementation of leadership strategies and tactics in a military environment. Topics include leadership theory and practice, honor and ethics education, and professional integrity. Exercises include small group discussion, leadership scenarios, and role-playing. Each cadet will perform at least one leadership position to include team leader, cadre, squad leader, platoon leader, company commander, or primary/special staff positions. May be taken up to 8 times. Pass/Fail only. (1H,1C)

2945-2946: SMALL UNIT LEADERSHIP FOR CADETS
Prepares cadets for responsibilities as small unit leaders. Builds on the previous year’s knowledge to focus on skills and knowledge necessary to lead small units. Introduces cadets to the importance of communication, includes basic counseling techniques, disciplinary actions, conflict resolution, cadet regulations and leadership case studies. Membership in the Corps of Cadets is required. (1H,1C)

2954: BUSINESS STUDY ABROAD
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to take management-related free electives. Pre: Instructor’s consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent. Variable credit course.

2964: FIELD STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3014: CAREER PLANNING STRATEGY FOR MANAGEMENT MAJORS
Career success/satisfaction focus for Management Majors in the Pamplin College of Business. Behavior-based interviewing and assessment to identify behaviors that are critical to specific career roles. Mastery of these behaviors to improve search strategies and employment outcomes. Strategies for developing professional networks of individuals and organizations. Emphasizes progressive development of features profiles that help students differentiate themselves from competitors and position themselves for desired career options. Ethical pursuit of employment and negotiation of job offers. (3H,3C)

3064: CORNERSTONES OF ENTREPRENEURSHIP AND INNOVATION
Provides a cornerstone foundation for the understanding of entrepreneurship and the business innovation process exposing students to fundamental business concepts applied and integrated in these arenas. An examination of value creation through entrepreneurship and the rudiments of new ventures are provided helping students develop an entrepreneurial frame of mind and perspective. Pre: Completion of 45 credit hours and two CLE Area 5 courses. (3H,3C)

3074: SOCIAL ENTREPRENEURSHIP
Provides a foundation for how social entrepreneurs use and combine resources to pursue opportunities that lead to social change and/or address social needs. An examination of the nature of social entrepreneurship and its various practices is provided, helping students develop an entrepreneurial frame of mind and prepare them to act as effective leaders of social change. (3H,3C)

3164: CURRENT TOPICS IN ENTREPRENEURSHIP
Topics in the field of entrepreneurship such as: developing a venture-backed company through initial public offering (IPO); building a startup venture from scratch to founder exit; attracting, securing, and deploying capital for entrepreneurial growth; corporate entrepreneurship; or other topics of expertise related to entrepreneurship. Aspects centered around core themes of examining the ethics of entrepreneurial solutions, relating the topic to current events, and expanding communication skills through oral and written delivery of a report. Pre: 1064 or 1104 or 3064 or ACIS 2115. (3H,3C)

3304: MANAGEMENT THEORY AND LEADERSHIP PRACTICE
This survey course introduces the student to a broad range of concepts, theories and practices important for a basic understanding of management. Topics also focus on the environment in which today’s managers must effectively operate. Pre: Sophomore standing. (3H,3C)

3314: INTERNATIONAL BUSINESS
The course provides a framework to show how a firm’s international business operations can be analyzed, understood, and managed, including discussion of cultural, social, political, and economic aspects of doing business abroad. The main learning experience in the course is oriented toward effective decision-making in the face of unique challenges faced by managers in the international business environment, with the goal of improving critical, analytical and creative thinking skills in international business operations. Junior Standing Required. (3H,3C)

3324: ORGANIZATION BEHAVIOR
This course examines the determinants and consequences of human behavior in formal organizations. Specific focus is on the individual, interpersonal, and group processes which underlie all the human dynamics. Co: 3304. (3H,3C)

3334: MANAGING HUMAN RESOURCES
Examines the strategies, policies, and practices associated with effectively managing human resources. Designed to provide future managers with tools and techniques to acquire, develop, reward, and retain employees within the legal and social context of today’s organizations. Emphasizes how managing human resources can contribute to organizational effectiveness in a variety of industrial and organizational settings.

Pre: 3304. (3H,3C)

3344: EMPLOYEE & LABOR RELATIONS
Examines employee and labor relations policies and practices from a legal, behavioral, social, and economic viewpoint. Covers the content and application of labor and employment laws. A focus on skills and knowledge associated with responding to employee organizing, negotiating employment contracts, and resolving employment disputes in private and public organizations. Union and non-union work settings in the United States and selected other countries. Pre: 3304. (3H,3C)

3404: PRINCIPLES OF MANAGEMENT
Management concepts, theories, and practices for the effective and successful operation of modern organizations. Four functions of management and the activities involved in each function. Importance of ethical management practices in the effective operation of global business organizations, including entrepreneurial ventures. Individuals and group behaviors in the workplace, as well as methods to improve workplace performance. Pre: 1104 or 1064. (3H,3C)

3424: HUMAN RESOURCE STAFFING AND DEVELOPMENT
Concentrates on the acquisition, deployment, and development of human resources within organizations. This course emphasizes the design and implementation of staffing, training, and development processes to achieve organizational objectives within social and economic constraints. Pre: 3304. (3H,3C)

3444: MULTICULTURAL DIVERSITY IN ORGANIZATIONS
Evaluates the impact of multicultural diversity on the employee's work experience and on organizational processes/ performance. Students analyze and discuss theories and practices related to the business case for diversity, exploring the processes through which multicultural diversity (both domestic and international) affects the organization and its stakeholders. Topics include multicultural diversity theories, legislation, interpersonal and international differences, cultural intelligence, and organizational practices. Pre: Junior Standing. (3H,3C) (3H,3C)

3604: MANAGERIAL ANALYTICS
Digital tools to analyze managerial data ranging from productivity data to large scale, organizational databases. Three themes: (1) analyzing and improving productivity using digital tools; (2) applying exploratory data tools; (3) improving organizational collaboration, analysis, and knowledge sharing using relational databases. Pre: ACIS 2504, BIT 2406. Co: 3304. (3H,3C)

3614: STRATEGY AND COMPETITION ANALYTICS
Develops concepts and techniques for analyzing and formulating strategy in a variety of business environments. Focuses on research, data, and analysis related to the key players in the environment from both a competitive and cooperative perspective. Basic frameworks for analysis include mapping the objectives and constraints of the players, and modeling the pattern of interaction among the players. Provides an in-depth exposure to the theory and tools of strategy analysis and practice in their management consulting application. Pre: ECON 2005, ACIS 2115, ACIS 2116, FIN 3104. Co: 3604. (3H,3C)

3754: MANAGEMENT INTERNSHIPS & CAREER DEVELOPMENT
Guided experience in work environments and job search. Through unpaid internships, students have the opportunity to view the inner workings of businesses first hand while working on organizationally meaningful assignments. Class activities prepare students for conducting effective job searches. Pass/Fail only. Pre: 3304. (1H,6L,3C)

3804: TOPICS FOR CADET GLOBAL LEADERSHIP STUDIES
Analyzes historic and current leadership challenges using specific military campaigns for context. Covers national and military objectives and various instruments of national power in relation to national security. Travel to relevant country and battlefields for experiential learning. May be repeated with different content for a maximum of six (6) credit hours. (3H,3C)

3935-3936: ADVANCED PROFESSIONAL DEVELOPMENT FOR CADETS
3935: Cadets in this learn about the mentor-protege relationship; resolving team conflicts; diversity in the workplace; standards of business conduct, dining etiquette; and maintaining a healthy lifestyle. A physical

fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required. (1H,2L,2C)

3945-3946: CADET ORGANIZATIONAL LEADERSHIP
Prepares junior class cadets for responsibilities as senior sergeants. Builds on the previous year's knowledge of small unit leadership. Introduces cadets to decision making, writing decision papers/executive summaries, project management, public speaking, and refinement of their personal leadership philosophy. Membership in the Corps of Cadets is required. (1H,1C)

3954: STUDY ABROAD
Variable credit course.

3964: FIELD STUDY
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4064: DEVELOPING ENTREPRENEURIAL VENTURES
Takes a cross-functional perspective on identifying and evaluating entrepreneurial opportunities, developing new ventures, and pursuing new venture strategies to compete in the marketplace. Explores business potentials of new venture ideas, examines new venture's feasibility, and develops business planning tools for the venture. Pre: Senior Standing. Pre: 3064, (BIT 3414, FIN 3104) or (BIT 3414, MGT 3304) or (BIT 3414, MKTG 3104) or (FIN 3104, MGT 3304) or (FIN 3104, MKTG 3104) or (MGT 3304, MKTG 3104). (3H,3C)

4084: MANAGEMENT CONSULTING
Hands-on application of accounting, finance, marketing, management, information technology, and project management to actual business clients through on-site consultation with start-up and existing businesses and non-profits. Through classroom instruction, instructor coaching, and experiential studies, students will use the skills they have learned over several semesters to explore the field of management consulting. For the Management major with senior standing in the Management Consulting Option. Pre: 3304. (3H,3C)

4094 (ENGE 4094) (IDS 4094): STARTUP: COMMERCIALIZATION OF INNOVATION
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback. (3H,3C)

4314: INTERNATIONAL MANAGEMENT
The course is designed to provide the student with familiarity concerning the unique problems, characteristics, and demands that face multinational managers and the international business community. Junior standing required. (3H,3C)

4324 (PHIL 4324): BUSINESS AND PROFESSIONAL ETHICS
An inquiry into the fundamental norms of conduct in business and other professions and their justification in relation to the most important ethical theories. Special attention will be given to moral problems such as the ethics of hiring and firing, bribery, and professional responsibility to society. (3H,3C)

4334: ETHICAL LEADERSHIP AND CORPORATE SOCIAL RESPONSIBILITY
Focus on the leadership role of managers in promoting ethics and corporate social responsibility in business today. Consideration of the overall role of business in society and specific business-society issues such as equity and identity at work, environmental pollution, consumer and employee concerns, corporate-community relations, and the activities of multinational corporations. Issues examined through conceptual frameworks of business ethics, corporate social responsibility, and leadership (especially servant leadership). Emphasis placed on students articulating analysis of such issues through written and oral communication. Pre: 2354 or 3304 or 3404. (3H,3C)

4344: PRODUCTIVITY AND QUALITY LEADERSHIP

This course provides an introduction to leadership in the context of productivity and quality improvement. It focuses on understanding the concepts and skills associated with contemporary management strategies and systems. This course requires active student involvement and emphasizes participative leadership skills, data collection, qualitative problem solving, and communication processes. For Management majors only. Senior standing required. Pre: 3304, 3324, 3604, BIT 3414. (3H,3C)

4354: LEADERSHIP: ADVANCES IN SKILLS AND CONCEPTS
This cornerstone course provides cutting-edge experiences, skills, and knowledge in leadership for students in the leadership minor. Within an historical context that balances military, political, and business perspectives, four types of leadership will be examined: self-leadership, dyadic leadership, team leadership, and enterprise leadership. Special emphasis will be placed on the specific skills, such as computer literacy and project management, required for leaders to succeed in modern, technologically oriented organizations. Pre: Senior standing. Pre: 2354 or 3304. (3H,3C)

4394: STRATEGIC MANAGEMENT
Senior-level capstone course to formulate and implement strategies to create and sustain competitive advantage. Emphasis on developing pragmatic and action-oriented general management skills that integrate across functional areas of the organization. Utilize various tools, concepts, and analytical framework to define and analyze strategic problems. Revisits business principles and practices covered in basic business courses. Pre: Senior standing. Pre: 3304, (MKTG 3104 or MKTG 3104H), FIN 3104, BIT 3414. Co: FIN 3054. (3H,3C)

4414: COMPENSATION AND PERFORMANCE MANAGEMENT
This course provides the knowledge and skills required by managers to design and implement comprehensive compensation and performance management systems in public and private organizations. Topics include development of compensation strategy, internal pay structure, determination of pay level through wage surveys, evaluating job performance, rewarding individuals and groups, and administering employee benefits. Pre: 3304. (3H,3C)

4854 (BIT 4854): ANALYTICS IN ACTION
Problem-solving framework and analytic techniques for solving messy, unstructured, high-impact, real-world organizational/societal problems within an interdisciplinary, intercultural, experiential learning context. Definition of problem scope, objectives, need for change, ethical concerns, and diversity and inclusion issues; identification of stakeholders and their values; evaluation of decision tradeoffs; problem decomposition and hypothesis formulation; project planning and administration; data versus user requirements, ethical and inclusive decision making, data collection, preparation, and analysis; team roles and management; professional communication of insights, policy and action recommendations. Pre: CMDA 2014, BDS 2005. (3H,3C)

4935-4936: CADET CITIZEN LEADER PRACTICUM
4935:Students in the class learn practical strategies for leading teams to plan execute a project; project writing; applied dining etiquette; being a mentor to others, leadership through service learning and living a healthy lifestyle. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required. (1H,2L,2C)

4944: LEADING IN YOUR PROFESSION
Examines the skills and knowledge necessary to succeed in a responsible role of leadership when beginning one’s career. It is a capstone course that draws on the leadership training and experience cadets have accumulated during their first three years in the Corps of Cadets. Senior standing in the Corps of Cadets required. Course may be taken twice for credit. The pre-requisite requirement is such that a student must take the pre-requisite twice before enrolling in this course. Pre: 2944. (1H,1C)

4945-4946: EXECUTIVE LEADERSHIP FOR CADET
S Examines executive level leadership. It explores executive decision making, constraint theory and problem solving in both the military and civilian career fields. Senior standing in the Corps of Cadets is required. (1H,1C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Mining and Minerals Engineering

Head: E.C. Westman
University Distinguished Professor and Nicholas T. Camicia Professor: R.H. Yoon
Professor: K.D. Luxbacher and E.C. Westman
Associate Professors: M. G. Karfakis, N. Ripepi, and E.A. Sarver
Assistant Professors: C. Cheng, E.S. Gilliland, A. Noble, B. Nojabaei, and W. Zhang
Adjunct Professor: J.A. Herbst

Web: **www.mining.vt.edu**

MINING & MINERALS ENGINEERING

calculate.
innovate.
communicate.

Overview

The Department of Mining and Minerals Engineering offers an engineering program containing aspects of

mineral science, engineering, and technology that is professionally related to the minerals industry. Graduates of this program find domestic and international employment opportunities with hardrock, coal, industrial minerals, and construction aggregates producers, as well as with government agencies and equipment vendors.

The mission of the department is to produce high quality, rigorously trained mining engineers, whose background and education reflect the current level of technology and thought of the profession, and who can enter directly into engineering practice or, alternatively, graduate school for further study. Specifically, the Department of Mining and Minerals Engineering seeks, as its educational objectives, to prepare alumni within a few years of graduation to possess:

- the intellectual ability to critically assess and tackle any engineering problem they may encounter;
- the communication skills to communicate technical information to a variety of audiences including technically trained supervisors and subordinates as well as non-technical members of the work force and the general public;
- the leadership and team building skills to lead projects and function as entry-level managers as well as work productively as members of a team;
- an understanding of the practical aspects of the mining industry and an appreciation for mining as a business; and
- an awareness of societal issues and how these issues affect their role as future professional engineers working for the general benefit of society.

The mining engineering curriculum utilizes the basic and engineering sciences to develop the various areas of activity of the mining engineer: mineral exploration, evaluation, development, extraction, mineral processing, conservation, protection of the environment, and mineral economics. Course work in these areas provides a unique background for engineering and management positions in industry and government, as well as for continuation of specialized graduate studies.

Intrinsic to the curriculum is the development of a meaningful, major engineering design experience that builds upon the fundamental concepts of mathematics, basic sciences, the humanities and social sciences, engineering topics, and communication skills. This design experience is stressed within the major and grows with the development and progression of the student. Ethical, social, safety, economic, and environmental considerations are emphasized in the design experience throughout many courses, including the capstone senior design course. Finally, the major engineering design experience is a focal point of the mining engineering curriculum and is consistent with the objectives and goals of the program.

The program has an emphasis on the application of computers to mining and minerals processing operations. Furthermore, it exposes students to laboratory courses which focus on conducting experiments, understanding the principles involved in each experiment, and analyzing and interpreting experimental data. Information on the mission, goals, and curriculum of the program is continuously updated on the departmental website.

The Cooperative Education Program, as well as opportunities for financial support in the form of scholarships, loans, awards, and summer employment, are available to undergraduate and graduate students. Graduate programs are available leading to the M.S., M. Eng., and Ph.D.

The B.S. degree program in Mining Engineering is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (MINE)

1984: SPECIAL STUDY
Variable credit course.

2114: ENERGY AND RAW MATERIALS: GEOPOLITICS AND SUSTAINABLE DEVELOPMENT
Supply and demand of energy resources and raw materials. Domestic and global trends. Development of energy and mineral resources. Electricity generation, efficiency, and distribution. Energy and raw materials infrastructure Disparities in resource-producing vs. resource-consuming regions. Environmental considerations and engineering management. Land use and reclamation. Greenhouse gas management. Policy, regulations, and incentives. Geopolitical considerations. Conservation and efficiency. Sustainable development. This course is available to undergraduate students of all ranks and all majors. (3H,3C)

2504: INTRODUCTION TO MINING ENGINEERING
Introductory course covering the complete field of Mining and Minerals Engineering with special emphasis on the evolution of discrete mining systems, interaction of mining with the environment and the inter-relationship of Mining and Minerals Engineering with other disciplines. (3H,3C)

2524: ELEMENTS OF MINE DESIGN
Basic concepts used in the modeling and design of mining systems including basic statistical concepts, sampling, geological and geostatistical modeling of ore bodies, ore reserve estimation, and selection of basic mine development methods. Pre: 2504, GEOS 1004. (2H,3L,3C)

2534: MINE SURVEYING AND MAPPING
Specialized principles of field surveying and mapping as applied to the delineation of mineral deposits and the design and monitoring of surface and underground mining operations. Introduction to modern surveying instruments, field techniques, and computational procedures. Basic digital mine mapping to include standard mine symbols and representation of surface and underground mine workings. Partially duplicates ENGE 2824. Pre: (ENGE 1104 or ENGE 1114), (MATH 1224 or MATH 2204 or MATH 2204H). (2H,3L,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3504: ROCK MECHANICS AND GROUND CONTROL
Properties and behavior of geologic materials and masses and their classifications and ratings. Design principles of structures founded on and in rocks and basic aspects of ground control. Pre: ESM 2204, GEOS 1004, MINE 2504. (3H,3C)

3514: ROCK MECHANICS LABORATORY
Laboratory techniques used in the determination of geologic materials properties and behavior. Determination of rock index properties, strengths, failure criterion and mechanical behavior. Co: 3504. (3L,1C)

3524: EXCAVATION ENGINEERING

Rock fragmentation for excavation; drilling fragmentation, rock drilling systems; blasting fragmentation, types and properties of commercial explosives and accessories, system of initiation, design of blasting rounds, applications in mining and construction, structural damage criteria, overbreak control, safe practice and regulations; fragmentation by excavation machines; excavation system selection and design. I Pre: GEOS 1004, ESM 2204, MINE 2504. (3H,3C)

3534: MINERAL PROCESSING
Principles of processing ores to recover valuable minerals. Basics of mineral processing including sampling theory, material balancing, slurry calculations, grade-recovery relationships, particle size analysis, process control. Unit operations including crushing, grinding and size separation. Applications to coal cleaning and crushed stone production. Pre: 2504. (2H,2C)

3544: MINERAL PROCESSING LABORATORY
Laboratory investigations of the unit operations and principles of mineral processing including ore preparation (size reduction, mineral liberation, and classification) and mineral recovery (froth flotation, electrostatic separation, magnetic separation, and solid-liquid separation). Pre: 3534. Co: 3554. (3L,1C)

3554: RESOURCE RECOVERY
Techniques for the separation and concentration of primary and secondary resources. Mineral concentration and waste recycling. Solid/solid concentration including gravity concentration, dense medium separation, froth floatation, magnetic separation and high tension separation. Solid/liquid separation including sedimentation/clarification, filtration and thermal drying. Overview of hydrometallurgical processing including leaching, solvent extraction and electrowinning. Pre: 3534, CHEM 1035. (2H,2C)

3564: UNDERGROUND MINE DESIGN
Design fundamentals of mining systems and stope development for tabular and massive underground mineral deposits. Equipment selection and application, permitting, cost analysis and production simulation. Pre: 2524, 3504. (3H,3C)

3574: SURFACE MINE AND QUARRY DESIGN
Surface mining methods, and their selection; mine planning and design; excavation, haulage and ancillary systems; equipment selection and maintenance; impoundment and piles design; mine closure/reclamation. Pre: 2524, 3524. (3H,3C)

3584: VENTILATION ENGINEERING
Subsurface ventilation systems. Ventilation planning and design, laws of airflow, airway resistance. Ventilation surveys, network analysis, ventilation economics. Ventilation software. Fan types, impeller theory, fan laws and testing. Mine ventilation thermodynamics. Pre: 2504, ESM 3024. (2H,3L,3C)

3984: SPECIAL STUDY
Variable credit course.

4504: MATERIALS HANDLING AND POWER SYSTEMS
Principles of materials handling, fluid power and electrical power systems for surface and underground mining operations. Engineering analysis and design of secondary haulage operations (belt conveyors, hoists, trucks, railways), fluid power systems (hydraulics, pumps, piping networks, compressors, pneumatic equipment). Electrical systems (electrical machinery, distribution networks, controls), and other ancillary systems required to support mining operations. Assessment of equipment reliability and development of preventive maintenance programs. Pre: ESM 3024. Co: ECE 3054. (3H,3C)

4514: HEALTH, SAFETY AND RISK MANAGEMENT
Study of risk analysis; mine legislation; mine gases, their occurrence, and physiological effects; methane emissions; dust classification, monitoring, and control; heat and humidity; psychrometry; physiological effects; climatic simulation; radiation monitoring and control; equipment hazards; noise; illumination; personal health and safety; fires and explosions; disaster management. Pre: 3564 or 3574. (3H,3C)

4524: PROJECT ENGINEERING AND MINE MANAGEMENT
Introduction to theory and practice of project engineering and management. Estimation of capital and

operating expenditures. Cash flow development, worth evaluation, comparison of alternatives, taxation/depreciation and optimization. Principles of financial management, accounting and resource utilization. Topical seminars by industrial representatives. Pre: 3564 or 3574. (3H,3C)

4535-4536: SENIOR DESIGN PROJECT
Investigation of a significant design problem in mining engineering under the supervision of a staff member. Periodic progress reports and submission of a comprehensive final design project including detailed drawings, engineering calculations, economic feasibility, and environmental impacts. Pre: 3564 or 3574 for 4535; 4535 for 4536. Co: 4524 for 4535. 4535: (3L,1C) 4536: (6L,2C)

4544: MINE RECLAMATION AND ENVIRONMENTAL MANAGEMENT
Statutory and regulatory controls on the mining environment. Air, water and land pollutants, standards, monitoring systems, and prevention and control techniques. Unique environmental issues, Surface Mine Conservation and Reclamation Act (SMCRA), endangered species, environmental impact statements, permitting, environmental audits and torts. Pre: 3574. (3H,3C)

4554: MINING ENGINEERING LEADERSHIP SEMINAR
Invited speakers, short-courses and workshops on subjects related to leadership issues in mining and minerals engineering. Technology and design; mining finances and marketing; management and business concerns; labor relations and leadership; team building, motivation, and communications; problem solving and performance measurements; environmental issues; permitting and regulatory requirements. Senior standing required. (3L,1C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course. X-grade allowed.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Marketing

Department Head: Rajesh Bagchi
Richard E. Sorensen Junior Faculty Fellow and Professor of Marketing: Rajesh Bagchi
Virginia-Carolinas Professor of Purchasing Management and Professor of Marketing: Paul M. Herr
Graduate Program Director: Mario Pandelaere
Robert O. Goodykoontz Professor of Marketing: David Brinberg
Sonny Merryman Inc. Prof. in Business and Prof. of Marketing, Founding Director of Ph.D. Program in Exec. Business Research: Dipankar Chakravarti
Mary F. McVay and Theodore R. Rosenberg Junior Faculty Fellow and Prof. of Marketing : Frank May
Professor and Real Estate Fellow: M.J. Sirgy
Associate Professors: E. Coupey and M. Pandelaere
Assistant Professors: J. Jiang and Frank May
Visiting Assistant Professor: R. Crabbe
Emeritus Faculty: N. Klein, J. E. Littlefield, M. M. Bird, and J. E. Keith
Professor of Practice: B. Collins
Advanced Instructor: T. Reilly
Instructor: L. Schirr and C. Swayne
Adjunct: J. Hsu and R. Buehrer
Advising: Pamplin College of Business, Undergraduate Programs Advising Center is located at 1046 Pamplin Hall. Students may schedule appointments by calling (540) 231-6602.

Web: **www.marketing.pamplin.vt.edu**

Overview

Marketing grows out of the concept of exchange between buyers and sellers. Driven by the needs and wants of the consumer, marketing managers develop new products, assign effective price levels, create promotional strategies, and develop the best distribution plans to guarantee that products reach the final consumer. Marketing also plays a crucial role in managing the efficient flow of goods and services from businesses to businesses. And managing marketing is growing even more exciting as technology and the internet enable managers to stay in closer contact with their customers and better manage this relationship. Marketing by manufacturing firms is well-known. Service industries such as banking and health care, however, are increasingly relying on marketing to improve service quality and delivery. Non-profit organizations, such as Habitat for Humanity and the American Red Cross, also use marketing to deliver social goods and services. All of these organizations benefit when they are able to use marketing concepts and tools to better understand their clients and design unique offerings that can meet their clients' needs.

The undergraduate program in marketing management is designed to offer the student a broad business education with an emphasis on professional training for development of marketing strategies and managing marketing operations. Virginia Tech Marketing graduates pursue a range of careers. They take jobs in marketing management, sales, advertising, retailing, and consulting positions in companies small and large. The curriculum is designed to provide core skills in marketing and to support this broad range of potential career interests.

In addition to the undergraduate program, the faculty in marketing management offer a master's and a doctoral degree for those students interested in more technical positions, such as marketing research; more rapid promotion with certain employers; or positions in higher education.

The department participates in the Cooperative Education Program in which qualified students may alternate semesters of study with semesters of professional employment.

The Marketing Department currently offers three degree options: Marketing- no concentration, Marketing-Sales concentration, and Marketing- Digital Marketing Strategy Concentration. In addition to the major, Marketing offers minors in Professional Sales and Digital Marketing Strategy to non-Marketing majors within the College of Business only.

The Professional Sales concentration and minor provide students with the knowledge and skills necessary to successfully enter the field of professional sales. Students will learn the necessary knowledge and skills needed to compete successfully in the respective field.

The Digital Marketing Strategy Concentration and minor provides students with the knowledge and skills to enter Marketing and related fields with technical experience in Digital Product delivery and developing, analyzing, and enhancing firms' products on the web, mobile, and social networks.

Requirements

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor Requirements

The requirements to earn a minor in Professional Sales can be found on its checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

The requirements to earn a minor in Digital Marketing Strategy can be found on its checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (MKTG)

2954: BUSINESS STUDY ABROAD
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to develop marketing-related free electives. Pre: Instructor’s consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent. Variable credit course.

2964: FIELD STUDY
Variable credit course.

2964H: FIELD STUDY
Honors section. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

3034 (REAL 3034): REAL ESTATE MARKET ANALYSIS
Market potential of residential, retail, office and industrial, hotels and resorts, and mixed use real estate development projects. Market analysis, identifying a market area, conducting demand and supply analyses, reconciling demand and supply. Pre: REAL 2034, (ECON 2005 or AAEC 1005). (3H,3C)

3104: MARKETING MANAGEMENT
Study of the marketing process from a macro and management viewpoint. The macro viewpoint includes

the role of marketing in society. The management viewpoint includes the product, distribution, promotional, and pricing decisions. Junior standing required. (3H,3C)

3104H: MARKETING MANAGEMENT
Study of the marketing process from a macro and management viewpoint. The macro viewpoint includes the role of marketing in society. The management viewpoint includes the product, distribution, promotional, and pricing decisions. Junior standing required. (3H,3C)

3504: ADVERTISING
Survey of advertising principles and its applications. The course covers advertising history, the impact of advertising on society, and ethical and regulatory issues. The process of creating and placing advertising is explored including advertising objectives, budgeting, media planning and mix, creative objectives and strategy, copy execution and production, and copy testing. Junior standing required. Pre: 3104 or 3104H. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4144 (CHE 4144): BUSINESS AND MARKETING STRATEGIES FOR THE PROCESS INDUSTRIES
Business strategies and industrial marketing concepts, and their application in the chemical, pharmaceutical and related process industries. The course is designed for engineers and other students planning a career in the process industries. Junior standing required. Pre: ECON 2005. (3H,3C)

4154: MARKETING RESEARCH
This course is a study of the scientific process of problem solving in a marketing context. It includes concepts of problem definition, hypotheses generation, questionnaire development, research design, implementation, analysis, and interpretation of statistical findings. Junior standing required. Pre: (3104 or 3104H), (BIT 2405 or STAT 3005), BIT 2406. (3H,3C)

4204: CONSUMER BEHAVIOR
An integrated analysis of individual and environmental influences on consumer decision making, purchase, and consumption behaviors with strong emphasis on implications for developing, executing, and assessing marketing strategy. Junior standing required. Pre: 3104 or 3104H. (3H,3C)

4204H: CONSUMER BEHAVIOR
An integrated analysis of individual and environmental influences on consumer decision making, purchase, and consumption behaviors with strong emphasis on implications for developing, executing, and assessing marketing strategy. Junior standing required. Honors section Pre: 3104 or 3104H. (3H,3C)

4254: PRODUCT AND PRICE MANAGEMENT
Emphasis on strategic branding and product planning within the context of marketing management. Analysis of economic, financial, legal, and marketing principles to make effective pricing decisions. Examination of relationships between product and price management. Junior standing. Pre: (3104 or 3104H), 4154, (4204 or 4204H). (3H,3C)

4264: ANALYTICS FOR MARKETING
Integrates conceptual and quantitative aspects of marketing. Provides concentrated emphasis on the role of analytical and computer models to enhance marketing decision making. Emphasis on managerial decision making in key areas, including segmentation and targeting, positioning, forecasting, new product design, forecasting and pricing. Role of consumer perceptions and behaviors on decision making. Hands-on experience with model building and using analytical tools. Pre: (3104 or 3104H), 4154, (4204 or 4204H). (3H,3C)

4304: MARKETING COMMUNICATIONS
Theory and application of an organization’s marketing communications function. Includes traditional and digital channels. Development of a marketing communications plan, situation analysis, setting communication goals, creating message strategy, implementing the strategy using promotional mix variables, planning traditional and social media, and determining the communication budget. Junior standing. Pre: (3104 or 3104H), (4204 or 4204H). (3H,3C)

4354: MARKETING CHANNELS AND LOGISTICS
Management of the firm's distribution function. Study of the structure, functions, interactions, and activities of marketing channels. Analysis and development of integrated physical distribution and logistics systems for the firm. Junior standing required. Pre: (3104 or 3104H), 4204, (BIT 2405 or STAT 3005), BIT 2406. (3H,3C)

4404: FIELD PRACTICUM IN MARKETING
Application of marketing concepts and theories to a specific business concept. On-site performance of marketing activities and a written analysis of the firm's marketing strategy and execution. Junior Standing Pre: 3104 or 3104H. (3H,3C)

4454: SALES FORCE MANAGEMENT
Integration of behavioral research to provide an understanding of the role of the salesperson within the sales organization and in relation to the buyers. Personal selling examines the dyadic interaction between buyer and seller. Managing the sales force covers planning, organizing, directing, and controlling the activities of the sales personnel. Junior standing required. Pre: 4554, (3104 or 3104H), 4204. (3H,3C)

4554: RELATIONSHIPS AMONG BUYERS AND SELLERS
Management of relationships between buyers and sellers among marketing organizations. Organizational buying, personal selling, and relationship marketing. The buying center and buying roles, the buying situation, the purchasing role, the sales process, personal selling approaches, negotiation, power and dependence, conflict resolution, and relational exchange. Pre: 3104 or 3104H. (3H,3C)

4604: RETAIL MANAGEMENT
Analysis of managerial problems in retailing establishments, including traditional and online formats. Focus is on operational problems, retail and e-retail store organization, location analysis, buying, selling, sales promotion, and merchandise handling. Junior standing required. Pre: 3104 or 3104H. (3H,3C)

4644: MARKETING, SOCIETY AND THE PUBLIC INTEREST
The impact of marketing on society from a multi- disciplinary and multi-stakeholder perspective. Marketing's role in solving societal problems is explored. Topics include at-risk market segments, controversial products and practices, and issues of social justice. Pre: 3104 or 3104H. (3H,3C)

4704: INTERNATIONAL MARKETING
Assessing international markets, comparing marketing systems; management of international marketing operations; focusing on distribution, promotional, and pricing problems faced by firms engaging in world trade. Junior standing required. Pre: 3104 or 3104H. (3H,3C)

4734: REAL ESTATE MARKETING
This course extends the fundamental concepts of marketing into the study and practice of real estate. The course is concerned with the topics of demographic analysis, market information systems, market research, and marketing strategy of residential and commercial real estate, with particular emphasis on the important area of real estate personal selling. Junior standing required. Pre: 3104 or 3104H. (3H,3C)

4754: STRATEGIC MARKETING
An integrative course in marketing policy and strategy, employing comprehensive case problems in the formulation of marketing action programs and business policy. Senior standing required. Any one of the following Marketing prerequisites--4304, 4354, 4554--may be taken concurrently with 4754. Pre: (3104 or 3104H), 4154, (4204 or 4204H). (3H,3C)

4754H: STATEGIC MARKETING
An integrative course in marketing policy and strategy, employing comprehensive case problems in the formulation of marketing action programs and business policy. Senior standing required. Any one of the following Marketing prerequisites - 4304, 4354, 4554 - may be taken concurrently with 4754H Pre: (3104 or 3104H), 4154, (4204 or 4204H). (3H,3C)

4774: ADVANCED PROFESSIONAL SELLING
Advanced theory and practice of professional selling with primary focus on the professional sales process,

analysis of associated strategic and ethical issues, and acquisition of critical skills required of successful salespeople. Builds on foundation created in Buyer/Seller Relationship (MKTG 4554) to expand knowledge and skills of students considering career in professional sales. Pre: 4554, 4204, (3104 or 3104H). (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4964H: FIELD STUDY
Honors section. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: HONORS UNDERGRADUATE RESEARCH
Variable credit course.

Naval ROTC

Head: Douglas A. Bradley, CAPT, USN
Professor: D. A. Bradley
Associate Professor: R. M. Stoddard
Assistant Professors: J. D. Matthews, P. J. Evans, Jr., A. E. MacDonald, M. T. Sullivan, and S. A. Lomeli

Web: **www.usnavy.vt.edu**

Overview

The Naval Reserve Officers Training Corps (NROTC) offers eligible young men and women the opportunity to earn commissions in the Navy or Marine Corps. NROTC midshipmen are required to complete the naval science curriculum and attend weekly laboratory sessions. During summer vacations, midshipmen participate in active duty at-sea or shore-based training facilities for periods of approximately four weeks. Students may enroll in the NROTC Program at the start of college or at the beginning of their sophomore year. Two-, three-, and four-year scholarships may be available for those who demonstrate outstanding potential. Upon completion of university degree requirements and the naval science program, qualified midshipmen are commissioned as Ensigns in the Navy (Navy-option) or Second Lieutenants in

the Marine Corps (Marine-option).

Students may join NROTC through any one of the following four programs.

Four-Year National Scholarship Program

Students enter the NROTC Four-Year Scholarship Program through national competition and are appointed Midshipmen in the Naval Reserve. While enrolled the government provides tuition, fees, uniform allowance, book allowance, and a monthly allowance. Students complete required naval science courses and participate in three summer training periods of approximately four weeks each. Upon graduation midshipmen are commissioned with an obligation to serve on active duty for at least five years.

Four-Year College Program

Students are enrolled in the Four-Year College Program upon acceptance by the Professor of Naval Science. Naval Science textbooks and a uniform allowance are provided and, during their junior and senior years if accepted for advanced standing, College Program students receive a monthly allowance. College Program students are obligated to complete the prescribed naval science curriculum, attend one summer at-sea training period, accept a commission in the Naval Reserve or Marine Corps Reserve upon graduation, and serve on active duty after graduation a minimum of three years for Navy personnel and 3-- 1/2 years for the Marine Corps.

Two- and Three-Year NSTC Controlled Scholarship Program

Students enrolled in the NROTC College Program and in good standing may be nominated by the Commanding Officer/Professor of Naval Science for a limited number of two- and three-year scholarships awarded by the Naval Service Training Command. If selected and found medically qualified, these students receive the same benefits and incur the same obligations as the Four-Year Scholarship Program.

Requirements for All Candidates

Qualifications for acceptable candidates for the Scholarship Programs or the College Programs include: U.S. citizenship; membership in the Virginia Tech Corps of Cadets; fulfillment of physical examination requirements; and willingness to participate in required summer training periods and to accept the appropriate commission in the Navy, Marine Corps, Naval Reserve, or Marine Corps Reserve when offered.

If not included in the requirements of their majors or the Curriculum for Liberal Education and college core curriculum, NROTC Navy-option scholarship students must complete the following: one year of college calculus through differential and integral calculus of one real variable; one year of calculus-based physics; one semester of American military affairs or national security policy; one year of English; and an Area 2 class approved by your NROTC advisor.

During NROTC enrollment, each midshipman will be required to pass semiannual physical fitness tests and to qualify as a swimmer before going on summer cruise.

Emerging Leader Scholarship Program

The University, in conjunction with the Virginia Tech Corps of Cadets Alumni Association, is offering a scholarship to incoming freshmen who are enrolled in an ROTC program and become members of the Corps of Cadets. Contact the Virginia Tech Corps of Cadets for more information.

Minor in Naval Leadership

The minor in Naval Leadership focuses on leadership development, both with regard to improving skills and personal character, with an emphasis on ethical professionalism as a warrior and national ambassador in a global context. The twelve (12) credit hours of required courses and nine (9) credit hours of elective courses are geared toward students actively seeking a commission in the United States naval services, but can also be appealing to students working in other disciplines throughout the university.

Undergraduate Course Descriptions (MN)

1004: INTRODUCTION TO NAVAL SCIENCE
A basic introduction to the Naval profession and concept of sea power. Explores the role of the commissioned officer and covers uniform regulations, the Uniform Code of Military Justice, Naval terminology, the Oath of Office, the Navy Ethos, and customs and courtesies. Also covers basic communication and the importance of training and qualification. The relationship to sea power and maritime strategy explained through the missions of the Navy and Marine Corps, briefly touching on the mission of other branches. Explains how directives are revised and published, as well as possible threats against platforms. Basic shipboard damage control covered with an emphasis on combating naval casualties. (3H,3C)

1104: NAVAL SHIPS SYSTEMS I: ENGINEERING
Ship characteristics and types. Includes ship design, hydrodynamic forces, stability, main propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control. One semester of college level science required. Pre: 1004. (3H,3C)

2004: NAVAL SHIPS SYSTEMS II: WEAPONS
Theory and employment of naval weapons systems. Includes threat detection, evaluation, weapon selection, delivery systems, guidance, and warhead design. Elements of command, control, and communications. (3H,3C)

2104: SEAPOWER AND MARITIME AFFAIRS
A survey of naval history from the American Revolution to the present with emphasis on major developments in strategy, tactics, and technology. Discussion of the geopolitical theory of Alfred Thayer Mahan. Explores present concerns in seapower and maritime affairs, including the economic and political dimensions of ocean commerce, the Law of the Sea, a comparison of U.S. and Soviet maritime strategies, and current naval affairs. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3005-3006: NAVIGATION AND NAVAL OPERATIONS
3005: An in-depth study of the theory and practice of piloting and introduction to celestial navigation. Students develop practical skills in the use of charts, visual and electronic aids. A study of the International Rules of the Nautical Road. 3006: Relative motion, vector-analysis theory, and ship employment. Includes an introduction to naval operations, ship characteristics, shiphandling, and afloat communications. I (3H,3C)

3204: EVOLUTION OF WARFARE
Development of warfare focusing on impact of major military theorists, strategists, and technicians. Ancient times to present. I Pre: 2104. (3H,3C)

4005,4006: LEADERSHIP AND MANAGEMENT/ETHICS
4005: Examines leadership skills, strategies, and contexts as interpreted through the lenses of the leader,

the follower, and the situation. Contrasts the roles of leader and manager within diverse constructs. Focuses on building and sustaining high-performance teams through transformational, charismatic and servant leadership. Challenges students to develop individual leadership skill development programs. Introduces general ethical theories and moral reasoning skills in the context of ethical decision making case studies, dark side trait analysis, and associated mitigation strategies. 4006: Explores philosophical schools of ethical thought in the context of targeted/representative case studies, both historical and contemporary in nature. Applies theoretical approaches to moral reasoning specifically as they pertain to ethical dilemmas within the rubrics of distributive justice and just war theory. Analyzes moral obligations as entailed by a voluntary oath of service. Examines strategies for mentorship, behavior reinforcement, and disciplinary options to optimize organizational success. Pre: Sophomore Standing. (3H,3C)

4204: AMPHIBIOUS WARFARE
Historical survey of the development of amphibious doctrine and the conduct of amphibious operations. Emphasis is on amphibious operations in World War II. Present day potential and limitations on amphibious operations are explored. I (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
II Variable credit course.

Army ROTC

Head: Paul A. Mele, COL., U.S. Army
Professor: P. A. Mele
Assistant Professors: M. Manigault, H. Johnson, I. McBride, D. Gallagan, B. Francis, E. Miller
Advisor: (540) 231-6401

Web: **www.armyrotc.vt.edu**

Overview

The Department of Military Science provides a program of leader development which prepares college men and women for service as officers in the United States Army. After graduation, they serve as commissioned officers on active duty, in the Army Reserves, or in the Army National Guard. To accomplish this, the department:

- Prepares Cadets to be commissioned as Second Lieutenants through a curriculum which develops leadership skills and provides opportunities to utilize these skills in a variety of experiential learning environments.
- Provides an understanding of how to lead and influence small organizations, with a strong emphasis on personal integrity, adaptability, critical thinking, innovation, agility, ethical decision making, goal setting, and mission accomplishment.
- Offers individual training including rappelling, land-navigation, marksmanship, and, for selected students, airborne, air assault, or combat diver training. Army sponsored international programs for cultural awareness and language training as well as internships with Army units and federal agencies worldwide

are also offered during the summer.
- In conjunction with the Virginia Tech Corps of Cadets, provides programs and experiences which increase self-confidence, self-discipline, physical stamina, resilience, and other attributes essential to the development of a leader of character--one who is prepared to serve the nation or community either in or out of uniform.

The curriculum and leader development programs of the Department of Military Science are mentally and physically challenging. Cadets learn individual soldier skills and participate in physical conditioning for all four years. On-campus instruction is done both in the classroom and in the field environment. Lab training and leadership development exercises expand the general knowledge of Cadets and provide opportunities for practical leadership experience. A six-week Leadership Development and Assessment Course is mandatory the summer between junior and senior year; the course is held at Fort Knox, Kentucky.

- Military Science I (freshmen) includes the semesters Introduction to the Army and Foundations of Agile and Adaptive Leadership. Cadets accept the Army as a Values-based organization and embrace the scholar-athlete-warrior ethos. They examine roles and responsibilities in military problem solving, the Army Leadership Requirements Model and traits necessary for effective small-unit leadership such as critical thinking, time management, and communication.
- Military Science II (sophomores) includes the semesters Leadership and Decision Making and Army Doctrine and Team Development. Cadets become grounded in the fundamentals of the Army Profession (Army Values, The Warrior Ethos, The Army Ethic), the foundational Army leadership doctrine, the Army's eight Troop Leading Procedures, the value of diversity, and an officer's role in leading change.
- Military Science III (juniors) includes the semesters Training Management and The Warfighting Functions and Applied Leadership in Small Unit Operations. Cadets examine and apply the individual and collective leadership skills to lead a platoon formation (up to 40 personnel) and train on giving and receiving peer evaluations, the fundamentals of organizational training management, and how the Army operates through the Warfighting Functions (such as mission command and movement and maneuver).
- Military Science IV (seniors) includes the semesters The Army Officer and Company Grade Leadership.

Army ROTC offers the conventional four-year military science program where a student enters as a freshman. A three-year program for sophomores is also available. Additionally, a two-year program is offered for juniors and graduate students in some limited cases. Placement credit may be awarded to students with prior Air Force, Navy, or Marine Corps ROTC experience, students with prior or current military service, or to those students who volunteer for additional summer training at Fort Knox, Kentucky.

Scholarships covering full tuition and fees are available for entering freshman though a High School National Army ROTC Scholarship Board process. Applications for these scholarships are available on-line at www.goarmy.com/rotc. Otherwise, Cadets enrolled in Army ROTC can compete for Campus Based scholarships through the department's Recruiting Operations Officer. All contracted Cadets (scholarship or non-scholarship) enrolled in the junior and senior years of ROTC are paid a tax-free monthly stipend of $420.00 for ten months during the school year. Membership in the Virginia Tech Corps of Cadets is a pre-requisite for all ROTC classes. The cost of cadet uniforms is paid by a special Army uniform allowance provided to each enrolled Cadet.

Minor in Leadership and Service

Satisfactory completion of the 26-credit military science curriculum will qualify each Cadet for a minor in Leadership and Service awarded by the Virginia Tech College of Liberal Arts and Human Sciences.

Undergraduate Course Descriptions (MS)

1005,1006: MILITARY SCIENCE I, ARMY RESERVE OFFICER TRAINING CORPS
First year of military science. MS 1005: "Introduction to the Army" introduces the personal challenges and competencies that are critical for effective leadership and communication. Student learning focuses on developing individual and interactive skills. Students learn how cultural understanding, goal setting, time

management, stress management, and comprehensive fitness relates to leadership and the Army profession. Students further learn the ROTC course structure and progression, and are immersed into Army organizational culture via classroom instruction, physical fitness training, and leadership labs. MS 1006: "Foundations of Agile and Adaptive Leadership" introduces students to basic knowledge required to be a successful member of a military team, to include the U.S. Army's mission, its role and relationship in the American governance system, U.S. military customs and courtesies, operational terms and graphics, map reading, land navigation squad tactics, the "Army Values" and "Warrior Ethos." This course includes reading assignments, homework assignments, practical exercises, a mid-term exam, and a final exam. Students receive systematic and specific feedback on leader attributes, values, and core leader competencies throughout the course. Successful completion of this course will help prepare cadets for Military Sci II, AROTC. (1H,3L,2C)

2005,2006: MILITARY SCIENCE II, ARMY RESERVE OFFICER TRAINING CORPS
Second year of military science. 2005: "Troop Leading Procedures" focuses on operations order production, leadership principles and styles, ethical and moral reasoning, land navigation and intermediate squad and platoon tactics. Required participation: leadership lab, physical training and field training exercises. 2006: "Unified Land Operations" focuses on doctrine and symbology, principles of joint operations, intermediate small unit tactics and leadership, effective communication, team building, counseling and coaching methods, code of conduct and law of land warfare. Required participation: leadership lab, physical training and field training exercises. Pre: 1005, 1006. (1H,6L,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3005,3006: MILITARY SCIENCE III, ARMY RESERVE OFFICER TRAINING CORPS
Third year of military science. 3005: "Training management and the warfighting functions" focuses on unified land operations, troop leading procedures, operations order production, written and oral communication, training management, squad leadership and tactics, squad and platoon offense/defense, land navigation, after action reviews, leadership, and physical training. Required participation: leadership lab, physical training and field training exercises. 3006: Applied leadership in small unit operations, squad and platoons offense/defense, basic rifle marksmanship, written and oral communication, land navigation, fires support to dismounted operations, leadership, physical training and preparation for advanced camp. Required participation: leadership lab, physical training and weekend field training exercises. Pre: 2005, 2006. (3H,3L,4C)

4005,4006: MILITARY SCIENCE IV, ARMY RESERVE OFFICER TRAINING CORPS
Fourth year of military science. 4005: "The Army Officer" focuses on development of the Army officer. It is an academically challenging course where students develop knowledge, skills, and abilities to plan, resource, and assess training at the small unit level. Students learn about Army programs that support counseling subordinates and evaluating performance, applying values and ethics to organizational problems, career planning, and legal responsibilities. Required participation: leadership lab, physical training and field training exercises. 4006: Company Grade Leadership focuses on preparing students to fulfill key leadership roles at the company level. This is an academically challenging course where students study, practice, develop, and apply critical thinking skills pertaining to Army leadership, officer skills, Army values and ethics, personal development, small unit tactics, platoon level leadership. Required participation: leadership lab, physical training and weekend field training exercises. Pre: 3005, 3006. (3H,3L,4C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Materials Science and Engineering

Head: D.E. Clark
Jack E. Cowling Professor: D.D. Viehland
Professors: D.E. Clark, D. Farkas, G-Q. Lu[1], K. Lu, M. Murayama, G.R. Pickrell, and W.T. Reynolds Jr.
Associate Professors: A.O. Aning, L.V. Asryan, S.G. Corcoran, E.J. Foster, L.J. Guido[1], C. Hin[3], and A.R. Whittington[2]
Assistant Professors: X. Bai, W. Cai, C. Tallon, H. Yu
Associate Professors of Practice: A.P. Druschitz, S. McGinnis
Collegiate Associate Professor: T.W. Staley
Research Associate Professors: J-F. Li and C.T.A. Suchicital
Instructors: C.B. Burgoyne[4], R. Clark
Professors Emeritus: J.J. Brown Jr., R.O. Claus, N.E. Dowling, G.V. Gibbs, D.P.H. Hasselman, R.W. Hendricks, and C.W. Spencer
Adjunct Faculty: C. Blankenship, J.T. Burns, T.W. Chan, M.M. Julian, S.L. Kampe, M.J. Kelley, R.G. Kelly, M. Khalifa, N. Manjooran, B. Risch, A. Savara, J.R. Scully, E. Trueman, and C. Van Tyne
Affiliated Faculty[5]: R.C. Batra[a], M.J. Bortner[j], S.W. Case[a], R.V. Davalos[e], S. Emori, A. Goldstein[j], J.R. Heflin[b], X. Jia[i], B. Johnson[k], F. Lin, H. Marand[c], R. Mirzaeifar[g], R.B. Moore[c], K. Ngo[i], M. Van Dyke[h], C.B. Williams[g], R.H. Yoon[d], and X. Zheng[g]

[1] Joint appointment with Electrical and Computer Engineering
[2] Joint appointment with Chemical Engineering
[3] Joint appointment with Mechanical Engineering
[4] Joint appointment with Biomedical Engineering and Mechanics
[5] Faculty with regular appointments in other departments: (a) Biomedical Engineering and Mechanics; (b) Physics; (c) Chemistry; (d) Mining and Minerals Engineering; (e) Institute for Critical Technology and Applied Science; (f) Nanoscale Characterization and Fabrication Laboratory; (g) Mechanical Engineering; (h)Sustainable Biomaterials; (i)

Electrical and Computer Engineering; (j) Chemical Engineering; (k) Industrial and Systems Engineering

Web: **www.mse.vt.edu**
E-mail: **undergrad@mse.vt.edu**

Overview

Materials engineers and scientists study the structure and properties of engineering materials on scales ranging from the atomic through the microscopic to the macroscopic. These materials include ceramics, metals, polymers, composites, biomaterials, nanomaterials, semiconductors, and electronic, magnetic, and photonic materials. Materials engineers develop new materials, improve traditional materials, and manufacture materials economically through synthesis, processing, and fabrication. They seek to understand physical and chemical phenomena in material structures and to measure and characterize materials properties of all kinds including mechanical, electrical, optical, magnetic, thermal, and chemical. They predict and evaluate the performance of materials as structural or functional elements in engineering systems and structures. They assist engineers in other disciplines and architects in selecting optimal materials for various applications.

Significant opportunities exist for graduates in the aerospace, automobile, transportation, medical, microelectronics, telecommunications, chemical, petroleum, energy storage, power generation, and energy conservation industries, as well as within the basic industries producing materials--for example, the copper, aluminum, steel, ceramics, glass, and polymer industries. Opportunities also exist in government-operated engineering centers and research laboratories. Graduates work in entry level engineering, manufacturing, materials selection and design, quality assurance and control, research and development, technical consulting, management, and sales and marketing. Graduates have an excellent background for post-graduate studies in science, engineering, medicine, law, and business.

Program Educational Objectives and Student Outcomes

Educational Objectives

The goal of the BS degree program in MSE is to provide the educational foundation that enables alumni to pursue their personal career objectives. Historically, the majority of our alumni become valued members of industrial and/or research teams within the field of materials science or related technical disciplines while a smaller percentage pursue graduate education or other personal career objectives.

The specific objectives for the BS degree program in MSE are to produce alumni who are:

- effective communicators with written, oral, and visual media:
- able to apply critical thinking skills to engineering and research problems: and
- effective learners able to apply technical tools, techniques, and knowledge specific to their field of employment or graduate studies.

Student Outcomes

Upon graduation, students completing the B.S. degree program in MSE will be able to:

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics including computational techniques to materials systems.
2. Apply engineering selection and design consistent with the program educational objectives to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. Communicate effectively with a range of audiences.

4. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. Develop and conduct appropriate experimentation, analyze and interpret data, apply statistical methods, and use engineering judgment (considering structure, properties, processing and performance) to draw conclusions.
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.

Curriculum

Students typically enter the MSE Department following completion of their first year studies within the College of Engineering, as administered by the Department of Engineering Education (EngE); a description of required first year coursework can be found within the EngE section of this catalog.

In addition to foundation courses in MSE, students tailor an individualized program of elective study. 12 credits of technical electives will be selected to emphasize certain subdisciplines of MSE (e.g., metals, ceramics, polymers, electronic materials, composites, biomaterials, nanomaterials, etc.) or to prepare for a career in certain application areas (e.g., manufacturing, aerospace, automotive, information technology, microelectronics, etc.). Course-work totals 126 credit hours as detailed on the BS in MSE checksheet which can be found at **http://registrar.vt.edu/graduation-multi-brief/index1.html**. Students expecting to graduate beyond the displayed checksheet years should use the last projected term until the checksheet for that calendar year becomes available.

The undergraduate curriculum contains a nationally recognized integrated program of instruction in engineering communication including writing, public speaking, proposal preparation, reporting, research skills, critical and creative thinking, and graphical presentation. More information regarding this unique program can be found at **https://mse.vt.edu**.

The undergraduate program culminates with a two-semester team-oriented engineering design project in which the students address a significant problem in their area of special interest. MSE is unique within the College of Engineering in that they offer a more ambitious project for students enrolled in the University Honors program.

The MSE students have pursued various minors including Microelectronics, Green Engineering, Chemistry, Mathematics, Music, a foreign language, and various others.

The B.S. in MSE degree program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, **http://www.abet.org**.

Educational Enhancement Opportunities

Students of MSE can optionally participate in the cooperative education program in which qualified students may alternate semesters of study with semesters of professional employment. (**www.career.vt.edu/experience/ceip.html**)

Honors-eligible students may participate in a formalized program of study leading to one of several university honors degrees (see **www.honorscollege.vt.edu**). MSE traditionally graduates several students with the degree "Bachelor of Science in Materials Science and Engineering (in Honors)", as well as some of the other Honors designations.

There are several department guided programs for study abroad and cultural exchanges. The MSE department has established relationships with several universities offering strong MSE programs in other countries. Programs in which the student studies abroad for one or two semesters typically have a foreign language requirement. At this time, programs are available in China, France, Germany and Switzerland. Students with interest in said programs are strongly advised to have at least two years of high school

experience with the appropriate language. Short-term (3 week) summer programs are available, which do not have a language requirement.

Undergraduate Course Descriptions (MSE)

1004: MATERIALS IN TODAY'S WORLD
An introductory course designed for the student with a basic high school science background who wishes to understand and learn about the exciting materials developments which are affecting us all in today's world. The course will introduce the structures and properties of metals, ceramics, polymers (plastics), composites, and materials for electronic and optical applications. Students will also gain an appreciation for the processing and design limitations of materials used in everyday applications. (1H,1C)

2014: MATERIALS ENGINEERING TRANSITION
Supplemental coverage of introductory topics not included in courses delivered to non-MSE majors. Pre: 2034 or 3094 or AOE 3094. (1H,1C)

2034: ELEMENTS OF MATERIALS ENGINEERING
This course is designed to introduce the non-MSE student to the structures and properties of metals, ceramics, polymers, and composites. In addition, students will gain an understanding of the processing and design limitations of these materials, as well as being introduced to new classes of materials being developed to meet the ever expanding range of material requirements. Non-MSE majors only. Pre: CHEM 1035. Co: PHYS 2305. (3H,3C)

2044: FUNDAMENTALS OF MATERIALS ENGINEERING
This course is designed to introduce the MSE major to the structures and properties of metals, ceramics, polymers, composites, and electronic materials. Students will also gain an understanding of the processing and design limitations of materials. Topics fundamental to the further study of materials, such as crystal structures, phase diagrams, and materials design and processing will be emphasized as foundations for future MSE courses. Pre: CHEM 1035. Co: PHYS 2305. (4H,4C)

2054: FUNDAMENTALS OF MATERIALS SCIENCE
Introduces MSE majors to fundamental underlying concepts governing phase equilibrium, microstructure, electronic properties of materials, and transport phenomena as a foundation to understanding materials behavior and processing. Pre: 2044. (3H,3C)

2114: MATH PROGRAMMING MSE I
Basic computational and graphical functions in mathematics oriented programming languages using data and engineering examples from the field of Materials Science. Students apply general methods to problems of their choice through mini- projects. Pre: 2044. (1H,1C)

2884: MATERIALS ENGINEERING PROFESSIONAL DEVELOPMENT I
Library engineering research skills, technical computer graphics, basic engineering workplace communication skills, basic engineering teamwork skills, introduction to engineering ethics, resumes and letters of introduction, gender issues in the workplace, professional poster presentations, and engineering public speaking. Pre: MSE major, sophomore status. (3L,1C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

29844: SPECIAL STUDY
Variable credit course.

2984D: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Variable credit course.

3044: TRANSPORT PHENOMENA IN MSE
Mass transport (continuum and atomistic diffusion), heat transport and fluid flow (momentum transport). Analytical and computer based methods for solving transport problems. Pre: 2044, MATH 2214. (3H,3C)

3054 (ESM 3054): MECHANICAL BEHAVIOR OF MATERIALS
Mechanical properties and behavior of engineering materials subjected to static, dynamic, creep, and fatigue loads under environments and stress states typical of service conditions; biaxial theories of failure; behavior of cracked bodies; microstructure-property relationships and design methodologies for homogeneous and composite materials. Pre: ESM 2204, (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684). (3H,3C)

3064 (ESM 3064): MECHANICAL BEHAVIOR OF MATERIALS LABORATORY
Laboratory experiments on behavior and mechanical properties of solid materials. Tension, compression, bending, hardness, nano-indentation, and impact tests; behavior of cracked bodies; fatigue and crack growth tests; creep deformation; microstructure-property relationships; laboratory equipment, instrumentation, and computers. Co: 3054. (3L,1C)

3094 (AOE 3094): MATERIALS & MANUFACTURING FOR AERO & OCEAN ENGINEERS
This course introduces the student of Aerospace and/or Ocean Engineering to the fundamental properties of materials typically required for structural design. The performance characteristics of metals, ceramics, polymers, and composites are presented and contrasted. Foundation principles underlying materials manufacturing are also presented with the goal of providing an understanding of how processing affects material properties and performance. Must have a C- or better in pre-requisite CHEM 1035. Non-MSE majors only. Pre: CHEM 1035. Co: ESM 2204, PHYS 2305. (3H,3C)

3104 (GEOS 3504): MINERALOGY
Principles of modern mineralogy, crystal chemistry, and crystallography, with emphasis on mineral atomic structure and physical property relationships, mineralogy in the context of geology, geochemistry, environmental science and geophysics, phase equilibria, mineral associations, and mineral identification, and industrial applications of minerals. There are three required field trips during the semester. Pre: (MATH 1016 or MATH 1025), CHEM 1036. (2H,3L,3C)

3114: MATHEMATICS PROGRAMMING IN MATERIALS SCIENCE II
Advanced computational and graphical methods in mathematics oriented programming languages. Students develop programs that solve and/or provide visualizations of solutions to materials science and engineering problems. Pre: 2114. (1H,1C)

3134: CRYSTALLOGRAPHY AND CRYSTAL STRUCTURES
Provides a comprehensive foundation in crystallography including lattices, point groups, space groups, reciprocal lattices, properties of x-rays, and electron density maps, all leading to a formal description of structures and an interpretation of the published crystallographic data. Pre: 2044. (3H,3C)

3204: FUNDAMENTALS OF ELECTRONIC MATERIALS
Introduction to the electrical, magnetic, and optical properties of solid-state materials. Development of atomic scale models for physical phenomena that are observable at the macroscopic scale. Connection is made between basic materials properties and the operational characteristics of selected solid-state devices. Pre: 2054, PHYS 2306. (3H,3C)

3304: PHYSICAL METALLURGY
Deformation of crystalline solids and its relationship to crystal structure and crystal defects: crystal structures

of metals, dislocations and plastic deformation, vacancies, recovery, recrystallization, grain growth, deformation twinning and martensite. Pre: 2044. (3H,3C)

3314: MATERIALS LABORATORY I
Sample preparation for materials characterization techniques including various types of microscopy, spectroscopy, diffraction, and hardness testing. Instruction in the use of heat treating equipment and polishing and chemical etching procedures. Pre: 2044. (3L,1C)

3324: ELEMENTARY METAL CASTING LABORATORY
Introduction to metal casting processes; gating, risering, molding and puring. Hands-on experience. Emphasis on safe foundry practices. Oral and written reports are required. Pre: (2034 or 2044), ISE 2214. Co: 3354. (3L,1C)

3334: TEST METHODS FOR FOUNDRY LABORATORIES
The properties of foundry sand, molten metal and castings are measured using standard laboratory test procedures. Safe foundry practices are emphasized. Oral and written reports are required. Pre: (2034 or 2044), ISE 2214. Co: 3354. (1H,2L,2C)

3344: GOVERNMENT REGULATION OF THE METAL CASTING INDUSTRY
Introduction to the role of federal, state, and local regulation of the metal casting industry. Implementation of OSHA, EPA, and DEQ regulations in an inherently dangerous industry. Emphasis is placed on the implementation of these regulations in a University environment as implemented in the VT-FIRE facility. Visits to VT-FIRE and other local production foundries are included. Oral and written reports required. Pre: (2034 or 2044), ISE 2214. (3H,3C)

3354: FOUNDRY SAFETY
Provides comprehensive training in foundry safety procedures and policies. (May register multiple times). Co: 3324 or 3334 or 4324. Pass/Fail only. Pre: (2034 or 2044), ISE 2214. (2H,1C)

3884: MATERIALS ENGINEERING PROFESSIONAL DEVELOPMENT II
Public speaking and workplace communications for materials engineers, business writing for the engineering workplace, teamwork skills, engineering ethics, collaborative writing, engineering management skills, and gender issues in the workplace. Extends the basic treatment of these topics given in MSE 2884. Pre: MSE major, junior status. Pre: 2884. (3L,1C)

3954: STUDY ABROAD
Variable credit course.

4034: THERMODYNAMICS OF MATERIALS SYSTEMS
Topics in thermodynamics on the solution of materials selection and design related problems such as materials stability at high temperatures and in corrosive chemical environments. Thermodynamic principles important in controlling equilibrium in single component systems and multicomponent solid solutions and in establishing the thermodynamic driving force in kinetic processes which are important in materials processing unit operations. Estimation of thermodynamic properties and equilibrium calculations in multicomponent and multiphase systems. Pre: 2044. Co: CHEM 1036. (3H,3C)

4044: POWDER PROCESSING
Processing methods associated with powder synthesis, characterization, colloidal processing, and forming of powder compacts. Theory of solid state and liquid phase sintering. Pre: 3044. (3H,3C)

4055-4056: MATERIALS SELECTION AND DESIGN I AND II
4055: Selection of materials for engineering systems, based on constitutive analyses of functional requirements and material properties. 4056: The role and implications of processing on material selection. Pre: 3044, 3054, (3204, 3304) or (3204, 4414) or (3204, 4554) or (3304, 4414) or (330 4, 4554) or (4414, 4554) for 4055; 4055 for 4056. (3H,3C)

4075-4076: SENIOR DESIGN LABORATORY
A capstone design course centered around an open-ended, faculty-advised senior project involving the design of a process, material, or a technique for solving a technological problem. Senior standing in MSE required.

Pre: 4644 for 4075; 4075 for 4076. Co: 4085, 4055 for 4075; 4086 for 4076. 4075: (3L,1C) 4076: (6L,2C)

4085-4086: SENIOR DESIGN RECITATION
Capstone course run in parallel with faculty-advised Senior Project Laboratory (MSE 4075-4076). Topics in engineering professional practice, project planning, and reporting. Preparation of proposals, interim reports, final project reports, and discussion of the environmental, social, and economic impacts of engineering. Instruction in design theory, ethics, continuous learning, and global issues. Senior Standing in MSE. Co: 4075 or 4095H for 4085. 4076 or 4096H for 4086. Pre: 3884 for 4085; 4085 for 4086. 4085: (2H,2C) 4086: (1H,1C)

4095H-4096H: HONORS SENIOR DESIGN-LABORATORY
Two-semester MSE capstone design course centered around an open-ended, faculty-advised senior honors project involving the design of a process, material, or a technique for solving a technological problem. Outcomes and work effort are consistent with that expected of honors students. MSE 4095H: Literature search, planning and proof-of-concept studies of assigned project. Individual preparation and presentation of an original senior honors thesis related to a team project in which the students also participate. Presentation of detailed project plan to faculty. MSE 4096H: Execution of proposed project, analysis of results and preparation of journal-quality presentation of results. Oral presentation of results to MSE faculty and students. Enrollment in University Honors and senior standing in MSE required. Pre: 4644 for 4095H; UH 4095H, MSE 4095 for 4096H. Co: 4085, 4055 for 4095H; 4086, 4086 for 4096H. (9L,3C)

4164: PRINCIPLES OF MATERIALS CORROSION
Introduction to the scientific principles of materials corrosion and corrosion protection. Topics include: thermodynamics of materials corrosion, including potential- PH (Pourbaix) diagrams, kinetics of corrosion reactions and mixed potential theory, types of corrosion (uniform, galvanic, crevice, pitting, fatigue, stress corrosion cracking, intergranular, and hydrogen embrittlement), material/environmental factors that promote or prevent the various types of corrosion, and methods and techniques of corrosion testing. Co: 4034. (3H,3C)

4174: CORROSION & DEGRADATION OF MATERIALS LABORATORY
Introduction to experimental techniques and principles used to study the effects of environmental exposure on various contemporary advanced materials systems. Emphasis on creation and measurement of property variations in engineered materials caused by time and chemical or energetic stimuli, and effective communication of these results. Pre: 4034, 3314, 4424. Co: 3044. (3L,1C)

4224: ELECTRONIC, MAGNETIC, AND OPTICAL PROPERTIES OF MATERIALS LABORATORY
Introduction to experimental techniques used to study the electronic, magnetic, and optical properties of contemporary advanced materials systems; property variations made possible by composition and processing of engineered materials; and interaction of fields with materials \023 including effective communication of these results. Pre: 3204, 3314, 4424. (3L,1C)

4234 (ECE 4234): SEMICONDUCTOR PROCESSING
Manufacturing practices used in silicon integrated circuit fabrication and the underlying scientific basis for these process technologies. Physical models are developed to explain basic fabrication steps, such as substrate growth, thermal oxidation, dopant diffusion, ion implantation, thin film deposition, etching, and lithography. The overall CMOS integrated circuit process flow is described within the context of these physical models. Pre: ECE 2204 or ECE 3054. (3H,3C)

4304: METALS AND ALLOYS
This course covers the production, properties and uses of commercially important metals and alloys. The influence of structure, chemistry, and processing upon the properties of metals is emphasized. Alloy selection is discussed. Mechanical, electrical, thermal and chemical characteristics of ferrous and nonferrous alloys are studied. Pre: 2034 or 2044. (3H,3C)

4305,4306: PHYSICAL METALLURGY AND MODELING OF METAL CASTING
4305: Casting processes; solidification and its influences on the structure and chemistry of castings; role of fluid flow and heat transfer in mold design; origin and control of casting defects. 4306: Design, layout, and modeling of metal components cast from aluminum, bronze, iron and steel; design of metal running systems; modeling of solidification process. Co: 3044 or ME 3304 for 4306. Pre: 3304 for 4305; (2034 or 2044), 3324 for 4306. (3H,3C)

4324: ADVANCED METAL CASTING LABORATORY
Advanced metal casting processes; no-bake sand molds; investment casting; rapid prototyping; melting and casting of aluminum, bronze, iron and steel. Casting finishing including shot and sand blasting. Hands-on experience. Emphasis on safe foundry practices. Oral and written reports are required. Pre: 3324. Co: 3354. (1H,3L,2C)

4334: APPLIED MATERIALS ANALYSIS
Fundamental materials theory applied to structure-property relationships in materials science and engineering through basic characterization techniques. Demonstrations, lab exercises, and practical application of modern characterization techniques such as Scanning and Transmission Electron Microscopy (SEM, TEM), Focused Ion Beam (FIB), and Atomic Force Microscopy (AFM). Pre: 2044, (3314 or 4424). (2H,3L,3C)

4384: NUCLEAR MATERIALS
An introduction to materials for nuclear applications with emphasis on fission reactors. Fundamental radiation effects on materials; material properties relevant to structural, moderator, reflector, blanket, coolant, control shielding and safety systems; processes such as nuclear fuel cycles, fuel enrichment and reprocessing; and related structural systems. Pre: (3044 or ME 3304), (MSE 3054 or ESM 3054 or ME 3614). (3H,3C)

4394: INTRODUCTION TO MOLECULAR DYNAMICS SIMULATION
Background of molecular dynamics simulation method. Fundamental molecular dynamics principles, algorithms and components (atomic structure, periodic boundary conditions, interatomic potentials, equations of motion of atoms, statistical ensembles, integration of equations of motion). Implementation of algorithms into codes. Simulations of the time evolution of atoms, particles, or molecules under static or varying thermodynamic conditions and external loads. Connection between atom trajectories and evolution of the physical property of the simulation system with statistical mechanics principles. Hands-on case studies using molecular dynamics simulation package, LAMMPS. Prior knowledge of a programming language such as Fortran, C, C++, Matlab, Mathematica, Python, Java is highly recommended. Pre: Junior standing. Pre: 2034 or 2044. (3H,3C)

4414: PHYSICAL CERAMICS
Study of the relationships between the physical properties (thermal, optical, mechanical, electrical and magnetic) and the structure and composition of ceramics at the atomic and microscopic level as affected by processing and service environment. Emphasis will be placed on application and design using structural ceramics. Pre: 2044. (3H,3C)

4424: MATERIALS LABORATORY II
Processing and characterization of materials; exploration of the influence of processing parameters on physical and mechanical properties. Emphasis on material synthesis. Pre: 2044. (3L,1C)

4434: CERAMIC & GLASS MATERIALS PROCESSING LABORATORY
Introduction to experimental techniques used to synthesize, process, and analyze resulting properties of ceramic and glass materials. Measurement of property variations made possible by changing composition and processing of engineered ceramic systems. Pre: 4414, 3314, 4424. (3L,1C)

4544 (CHEM 4074): LABORATORY IN POLYMER SCIENCE
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems. Pre: CHEM 3616, CHEM 4534. (1H,3L,2C)

4554: POLYMER ENGINEERING
This course is designed to introduce the student to polymers from the MSE perspective. The basics of polymer syntheses and polymerization will be outlined. The relationship between processing, structure, and properties will be presented with respect to the performance and design requirements of typical polymer applications. Pre: 2044. (3H,3C)

4574: BIOMATERIALS
Materials for biomedical applications. Basic material types and properties, functional uses of materials in

medical applications, and tissue response mechanisms. Integrated design issues of multicomponent material design in prosthetic devices for hard and soft tissues, orthopedics , cardiovascular, and drug delivery applications. Pre: 3054 or ESM 3054. (3H,3C)

4584: BIOMIMETIC MATERIALS
Introduction to structure property relationships in biological materials such as wood, bone, shells, spider silk, connective tissue, blood vessels and jellyfish. Proteins and polysaccharides, biosynthesis and assembly, biomineralization, hierarchical organization. Introduction to tissue engineering and regenerative medicine. Life cycle, environmental aspects of biofabrication. Pre: (2034 or 2044), (CHEM 1036 or BIOL 1106). (3H,3C)

4604: COMPOSITE MATERIALS
The application of the fundamental concepts of mechanics, elasticity, and plasticity to multiphase and composite materials. Constitutive equations for the mechanical and physical properties of metal, ceramic, and polymeric matrix composites. The role of processing and microstructure on properties. Pre: (2034 or 2044), ESM 2204. (3H,3C)

4614: NANOMATERIALS
Synthesis methods of 0D nanoparticles, 1D nanotubes/nanowires/nanorods, 2D nanoribbons and nanofilms, and special nano-features on supports. Bottom-up and top-down approaches. Methods of characterization for nanomaterials. Processing of nanospecies into higher order dimensions; conventional processing techniques; techniques developed solely for nanomaterials. Chemical, physical, mechanical, and electrical properties of nanomaterials and applications of nanomaterials. Pre: 4034. (3H,3C)

4644: MATERIALS OPTIMIZATION THROUGH DESIGNED EXPERIMENTS
Methods of analysis of variation in materials systems, manufacturing or R&D through the use of statistical methods including experimental design techniques. Instructional examples related to Materials Science and Engineering. Pre: (3314 or 4424). (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Music

Chair: Jason Crafton (Interim)
Professors: W. J. Crone
Associate Professors: I.I. Bukvic, W. E. Easter, W. J. Glazebrook, E. Lyon, C. Nichols, A. Weinstein, and Ariana Wyatt
Assistant Professors: D. Bigler, J. Crafton, A. Stevens, B. Thorsett, and H. Yoo
Instructors: J. Bean, E. Crone, A. Cowan, M. E. Dunston, K. Hutchins, J. Irrera, R.J. Masters, P. Middleton, and C. Reep
Professor Emeritus: D. Widder, J. Husser, V. Burnsed, and D. Jacobson
Academic Advisor: Tammy Henderson

Web: **www.performingarts.vt.edu**

Overview

The Virginia Tech Department of Music provides high-quality training to a select number of music majors, as well as ensembles and courses for large numbers of non-music majors. Instruction takes place in a handsome new facility which has superb rehearsal rooms, well-designed practice rooms and music teaching studios, a beautiful acoustically engineered Recital Salon, and laboratories with state-of-the-art electronic equipment for music study, recording, and digital music.

The curriculum offers an excellent liberal arts education with a low professor/student ratio combined with the library, computer facilities, and cultural interaction which only a major comprehensive university can provide. Learning is enhanced by the use of music technology across the curriculum and innovative programs such as laboratory ensembles and extensive teaching experiences in the music education

program. Together with traditional degree programs in Performance, Music Education, Technology and Composition, students may design a degree plan combining music with virtually all other majors offered by the university.

Virginia Tech faculty artists and scholars have performed and lectured at conventions, in music festivals, and on concert series throughout the United States and in Canada, Europe, Asia, and South America. Each year, internationally known guest artists join forces with our faculty to perform world caliber performances on campus.

Prospective music majors must successfully complete an audition/interview. Contact the chairperson of the Music Scholarship and Audition Committee, School of Performing Arts, 195 Alumni Mall (0141), Henderson Hall, Room 247, Blacksburg, Virginia 24061-0240 to receive information concerning auditions and scholarship opportunities. Scholarship support is available. Please also refer to the School of Performing Arts general information section for details.

The major in music, leading to a B.A., emphasizes four areas of music: music education; performance; technology and composition as well as a designed option. This designed option area is provided as a means for a student to tailor music and non-music courses into a curriculum that best meets the interests of the student. In addition to fulfilling the Curriculum for Liberal Education and the core curriculum requirements of the College of Liberal Arts and Human Sciences, the music major must pursue a concentration in one of the above areas of emphasis.

There are eight primary options available to music majors. These are:

- 84-Credit Music Education Option (see website for details)
- 51-Credit Performance - Liberal Arts Option
- 78-Credit Performance - Professional Vocal Option
- 78-Credit Performance - Professional Instrumental Option
- 78-Credit Composition - Professional Option
- 52-Credit Music Technology - Liberal Arts Option
- 78-Credit Music Technology - Professional Option
- 54-Credit Creative Technology - Liberal Arts Option

In addition, all music majors must meet a minimum level of piano proficiency no later than two semesters prior to graduation. Music majors are expected to participate in an ensemble or as an accompanist every semester of residence and attend a minimum number of concerts and recitals. Additional curriculum and policy information is available in the *Handbook for Music Majors* on the department website.

There are three options available as a minor in music, including a general option, a music technology option and a jazz option. The minor in music consists of 18 semester hours selected from performance, history/literature, and theory/composition. Interested students should contact Tammy Henderson, Virginia Tech, 246 Henderson Hall, Blacksburg, Virginia 24061-0240 or at tammyh@vt.edu for the exact requirements.

The department follows the Curriculum for Liberal Education except in Area 4 - Scientific Reasoning and Discovery, of which two credits of laboratory science are not required. Both the Department of Music and the university foreign language requirement are the same, except for vocal performance majors.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a

transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in music.

Satisfactory progress requirements toward the B.A. in Music can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (MUS)

1004 (TA 1004): SCHOOL OF PERFORMING ARTS FIRST YEAR EXPERIENCE
Orientation to the School of Performing Arts philosophy and the resources of the School, the College, and the University. Cultivate a common intellectual, analytical, and creative conversation among first-year students. Enhance student participation in the creative and scholarly life of the School's programs. Foster a sense of community and understanding across disciplines. (1H,1C)

1005-1006: THEORY/FUNDAMENTALS
Development of understanding the basic components of the composition of music through reading and writing the symbolic notation as it appears on the page, and realizing the experimental and expressive content of music performance through singing, ear training, and practice at a keyboard instrument. (3H,3C)

1104: MUSIC APPRECIATION
Survey of the art of music encompassing a variety of music styles and historical eras in both the western and non- western world. Students will develop strategies to contextualize music, via listening, from the perspective of the listener, composer, and performer. (3H,3C)

1114: LISTENING IN THE DIGITAL AGE
An introduction to musical access and listening in the digital age. Introduces basic elements of music and the creative process together with important musicians and their works. Explores historical, social, and cultural forces and trends that influence the creation and interpretation of various musical styles, including classical, blues, jazz, popular, and world music. (3H,3C)

2025-2026: THEORY/HARMONY
Study of structure, relationship, and function of chords through harmonization of bass and melody lines and through written analysis. Majors and minors only. Pre: 1006. Co: 2045 for 2025; 2046 for 2026. (3H,3C)

2045-2046: SIGHTSINGING LABORATORY
Study and practice of techniques involved in the sight reading and sightsinging of printed music. Majors and minors only. Co: 2025 for 2045; 2026 for 2046. (3L,1C)

2054: INTRODUCTION TO MUSIC TECHNOLOGY
History, theory, and applications of music technology for notating music and recording and editing audio, using computer software and digital audio equipment. Consent Required. (3H,3C)

2055-2056: AUDIO TECHNOLOGY FOR MUSIC
Develops basic understanding of audio technology for musical applications, focusing on today's digital audio recording and editing technologies including microphone use, live recording, and studio session recording. Develops critical listening skills through lab experimentation and recording. Pre: 2054 and permission of instructor required. Pre: 2054. (3H,3C)

2065-2066: MUSIC COMPOSITION
Organizing the basic elements of music: pitch, rhythm, timbre, articulation, and dynamics. Composing pieces for solo instruments and duos. Preparing scores and parts, for performances and recordings of the compositions. Knowledge of basic music theory required. Consent Required. (2H,2C)

2115,2116: SURVEY OF WESTERN MUSIC
Survey and study of the historical evolution of Western art music. MUS 2115: classical music from Antiquity into the Classical era. MUS 2116: classical and other music from the Romantic era through the 20th century to music of today. Investigation of the materials of music. Exploration of music as it both reflects and impacts history, including historical considerations of gender, race, culture, and other extramusical factors. Relevance of historical and contemporary music to our society today. (3H,3C)

2124 (APS 2124): MUSIC TRADITIONS IN APPALACHIA
Survey and study of music traditions in Appalachia. Investigation of the formal elements of this music, including instruments and musical terms and forms. Exploration of style as a reflection of many cultural influences. Study of the impact and development of these traditions in contemporary musical practices. (3H,3C)

2214: CLASS APPLIED PIANO
Group piano lessons for beginners or for students at an early stage of keyboard development. May be repeated for 1 credit. Consent required. (3L,1C)

2224: CLASS APPLIED VOICE
Group voice lessons for beginners or for students at an early stage of vocal development. May be repeated for 1 credit. Consent required. (3L,1C)

2234: CLASS APPLIED STRINGS
Group string lessons for beginners or for students at an early stage of string development. May be repeated for 1 credit. Consent required. (3L,1C)

2244: CLASS APPLIED WOODWINDS
Group woodwind lessons for beginners or for students at an early stage of woodwind development. May be repeated for 1 credit. Consent required. (3L,1C)

2254: CLASS APPLIED BRASS
Group brass lessons for beginners or for students at an early stage of brass development. May be repeated for 1 credit. Consent required. (3L,1C)

2264: CLASS APPLIED PERCUSSION
Group percussion lessons for beginners or for students at an early stage of development. May be repeated for 1 credit. Consent required. (3L,1C)

2274: MUSIC EDUCATION LAB ENSEMBLE
Music education laboratory ensemble. Performance techniques, teaching methods, management procedures, materials and literature for school music ensembles. May be repeated for credit. (1L,1C)

2284: PIANO ACCOMPANYING
Examine and practice the skills necessary for successful piano accompanying. Develop keyboard skills such as sightreading, transposition, choral score reading, and harmonization. Learn principles of accompanying vocal repertoire, instrumental repertoire, including large ensemble repertoire; adapt orchestral reductions for piano. Instructor consent required. (2H,2C)

2514: INDIVIDUAL APPLIED VOICE
Individual instruction in voice. May be repeated. Consent and audition required. Variable credit course.

2515-2516: VOCAL DICTION
An introduction to principles of vocal diction for singing using the International Phonetic Alphabet and standard foreign-language pronunciation techniques. Two semesters. Fall semester: Italian, Latin, and English. Spring semester: French and German. One credit hour. Pre: 2514 or 4514. (1L,1C)

2524: INDIVIDUAL APPLIED KEYBOARD
Individual instruction in keyboard. May be repeated. Consent and audition required. Variable credit course.

2534: INDIVIDUAL APPLIED VIOLIN
Individual instruction in violin. May be repeated. Consent and audition required. Variable credit course.

2544: INDIVIDUAL APPLIED VIOLA
Individual instruction in viola. May be repeated. Consent and audition required. Variable credit course.

2554: INDIVIDUAL APPLIED CELLO
Individual instruction in cello. May be repeated. Consent and audition required. Variable credit course.

2564: INDIVIDUAL APPLIED BASS
Individual instruction in bass. May be repeated. Consent and audition required. Variable credit course.

2574: INDIVIDUAL APPLIED FLUTE
Individual instruction in flute. May be repeated. Consent and audition required. Variable credit course.

2584: INDIVIDUAL APPLIED OBOE
Individual instruction in oboe. May be repeated. Consent and audition required. Variable credit course.

2594: INDIVIDUAL APPLIED CLARINET
Individual instruction in clarinet. May be repeated. Consent and audition required. Variable credit course.

2604 (TA 2604): INTRODUCTION TO ARTS MARKETING
An introduction to the theories and practice of marketing and building community engagement as applied to arts activities and professional not-for-profit arts organizations, through a survey of standard marketing approaches, examination of current practices in the field and direct hands-on experience. (3H,3C)

2614: INDIVIDUAL APPLIED SAXOPHONE
Individual instruction in saxophone. May be repeated. Consent and audition required. Variable credit course.

2624: INDIVIDUAL APPLIED BASSOON
Individual instruction in bassoon. May be repeated. Consent and audition required. Variable credit course.

2634: INDIVIDUAL APPLIED HORN
Individual instruction in horn. May be repeated. Consent and audition required. Variable credit course.

2644: INDIVIDUAL APPLIED TRUMPET
Individual instruction in trumpet. May be repeated. Consent and audition required. Variable credit course.

2654: INDIVIDUAL APPLIED TROMBONE
Individual instruction in trombone. May be repeated. Consent and audition required. Variable credit course.

2664: INDIVIDUAL APPLIED BARITONE
Individual instruction in baritone. May be repeated. Consent and audition required. Variable credit course.

2674: INDIVIDUAL APPLIED TUBA
Individual instruction in tuba. May be repeated. Consent and audition required. Variable credit course.

2684: INDIVIDUAL APPLIED PERCUSSION
Individual instruction in percussion. May be repeated. Consent and audition required. Variable credit course.

2714: INDIVIDUAL APPLIED HISTORICAL WIND INSTRUMENTS
Individual instruction in historical wind instruments. May be repeated. Consent and audition required.

Variable credit course.

2724: INDIVIDUAL APPLIED HISTORICAL STRING INSTRUMENTS
Individual instruction in historical string instruments. May be repeated. Consent and audition required. Variable credit course.

2734: INDIVIDUAL APPLIED COMPOSITION
Individual instruction in composition. May be repeated. Consent and audition required. Variable credit course.

2754: INDIVIDUAL APPLIED RECORDING
Individual instruction through directed experiential learning of music recording and production. Integration of critical listening, acoustics, audio recording, and signal processing with music theory and performance. An emphasis on hands-on exploratory research in the use of instruments, acoustics, and microphone techniques combined with traditional methods and emerging technologies to capture and produce recordings of musical performances and works in a natural and effective manner. Permission required. May be repeated for a maximum of 8 hours. Variable credit course. Pre: 2055.

2815-2816: JAZZ IMPROVISATION
Fundamental principles of jazz improvisation. Topics include interval relationships, chord identification, modes and modality, blues and ii-V-I chord progressions. Pre: Permission of instructor required. (2H,2C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3024: COUNTERPOINT
Study of the development and aesthetics of contrapuntal techniques throughout the common practice period. Pre: 2026. (3H,3C)

3035-3036: ADVANCED CLASS PIANO
Develop keyboard skills such as sightreading, harmonization, transposition, learn all scales/arpeggios and important keyboard progressions. A grade of C or better required in prerequisite. Pre: 2214 for 3035; 3035 for 3036. (3L,1C)

3044: ORCHESTRATION & ANALYSIS
An introduction to the craft of scoring and arranging of music for full orchestra. Analysis of scores, small projects and a full orchestration project. Pre: 3034. (3H,3C)

3045-3046: ADVANCED EAR TRAINING
3045: Hearing chromatic chord function in melodic and harmonic contexts. Sight-singing chromatic melodies and performing chromatic progressions. Aurally recognizing musical form (binary, ternary, strophic). Discovering markedness in common practice era music and recognizing commonalities with and differences from other music cultures A grade of C or better required in prerequisite. 3046: Hearing chord function in advanced chromatic melodic and harmonic contexts. Sight-singing advanced chromatic melodies and performing highly chromatic progressions. Aurally recognizing musical form (sonata, rondo, other forms). Hypothesizing about evolution of style and articulating intertextual experience. A grade of C or better required in prerequisite. Pre: 2046 for 3045; 3045 for 3046. (3L,1C)

3054: INTRODUCTION TO VOCAL/CHORAL ARRANGING
Techniques of arranging music for vocal/choral ensembles. Emphasis on transcription from recordings to develop rhythmic, melodic, and harmonic dictation skills. Discussion, transcription, listening, small writing exercises, final project. Pre: 3035, 3036. (3H,3C)

3055-3056: MUSIC AND MEDIA PRODUCTION
Develops advanced knowledge of music production through practical application of music recording and production technologies, including advanced microphone techniques, critical listening, and critical artistic evaluation skills. Individual and group production projects. Hands-on experience with a variety of expressive media technologies including CD and DVD production in a collaborative, inter- disciplinary team approach. Pre: 2056. (3H,3C)

3064: DIGITAL SOUND MANIPULATION
Study of recording technology and its effects on music. Aesthetics of electronic music. Recording and editing digital sound. Visual programming for live sound synthesis and processing. Acoustic compilers for programmatic sound processing and synthesis. Individual creative applications of tools learned in class. Team-based work on creative projects. (3H,3C)

3065-3066: COMPUTER MUSIC AND MULTIMEDIA DESIGN
A two-semester study of interactive multimedia composition and performance software as a foundation for creative work and research endeavors. Also provides an in-depth study of digital sound synthesis, algorithmic creation of multimedia content, and the design of audio-visual interactive systems using latest technologies. Must meet pre-requisite or have permission of the instructor Pre: 2054 for 3065; 2054, 3065 for 3066. (3H,3C)

3114: SYMPHONIC LITERATURE
Study of representative works of symphonic music from the eighteenth, nineteenth, and twentieth centuries, with corollary readings in the history of musical ideas. Consent required. (3H,3C)

3115,3116: MUSIC IN AMERICA
An introduction to the history and stylistic evolution of American music from the seventeenth century to the present. (3H,3C)

3124: 20TH CENTURY MUSIC LITERATURE
An introduction to music in Europe and America since 1945; supplementary study in the aesthetics of contemporary music. Consent required. (3H,3C)

3134: VOCAL MUSIC LITERATURE
Covers vocal music of Europe and America, especially music composed the eighteenth century. Examines differences in style and forms of choral and solo-vocal expression characteristic of the Baroque, Classic, Romantic, and Modern eras. Discusses issues of vocal performance practice. Ability to read music required. (3H,3C)

3135-3136: HISTORY AND ANALYSIS OF MUSICAL STYLES
The history of Western music from 1100 to the present as an evolution of musical styles. Extensive analysis of the music, stylistic attributes, normative forms, and representative literature of each period. Historical and philosophical background of each period. The study of analytical techniques to improve comprehension and performance. Pre: 2026 for 3135; 2026, 3135 for 3136. Co: 3145 for 3135; 3146 for 3136. (3H,3C)

3144: EARLY MUSIC LITERATURE
Covers vocal and instrumental music from the Middle Ages to the eighteenth century. Examines differences in style and forms of expression characteristic especially of Medieval, Renaissance, and early Baroque music. Discusses issues of performance practice. Ability to read music required. (3H,3C)

3145-3146: MUSICAL STYLES LITERACY LABORATORY
Aural study of Western music from 1100 to the present as an evolution of musical styles. Extensive listening to the music of each stylistic period. Supervised as well as self-paced study using HyperMedia technology. Automated examinations. Co: 3136, 3135 for 3145. (1L,1C)

3154: PIANO LITERATURE
Study of representative works of keyboard repertoire from the 17th century to the works of contemporary composers. Extensive stylistic analysis and discussion of performance practice. Pre: consent required. (3H,3C)

3164: HISTORY OF ELECTRONIC MUSIC
Seminal electronic music works in historical context. Electronic music practices of the 20th and 21st centuries. The technologies of electronic music. Analysis of electronic music. Historical origins and trends in electronic music. Connections between experimental and popular electronic music forms. (3H,3C)

3164H: HISTORY OF ELECTRONIC MUSIC
Seminal electronic music works in historical context. Electronic music practices of the 20th and 21st centuries. The technologies of electronic music. Analysis of electronic music. Historical origins and trends in electronic music. Connections between experimental and popular electronic music forms. (3H,3C)

3214: TEACHING MUSIC IN THE ELEMENTARY SCHOOL
Methods of teaching elementary school music. Emphasis on Kodaly, Orff, and traditional music textbook series approaches to teaching music in elementary schools. Pre: Instructor permission and successful completion of sophomore music continuation exam. Co: 4964. (3H,3C)

3225-3226: CONDUCTING
An introduction to the practice and theory of ensemble conducting and leadership. 3225: Basic conducting skills, and choral conducting. 3226: Intermediate conducting skills, and instrumental conducting. Consent required. (3H,3C)

3234: PIANO PEDAGOGY
Examination of principles and practice of piano pedagogy. Covers teaching methods, materials and literature for the independent studio teacher. Pre: consent required. (3H,3C)

3314: INSTRUMENTAL ENSEMBLE MUSIC
Instruction and participation in instrumental music performance ensembles under direction of members of the music faculty. Attention to technical proficiency, stylistic elements, musical design and interpretation in the works to be performed. Addresses ethical obligations and practice in a music ensemble setting. May be repeated for a combined maximum of 8 hours. Consent and audition required. (3L,1C)

3414: CHORAL ENSEMBLE MUSIC
Instruction and participation in choral music performance ensembles under direction of members of the music faculty. Attention to technical proficiency, stylistic elements, musical design and interpretation in the works to be performed. Addresses ethical obligations and practice in a music ensemble setting. May be repeated for a combined maximum of 8 hours. Consent and audition required. (3H,1C)

3815-3816: ADVANCED JAZZ IMPROVISATION
Topics will include in-depth analysis of the great improvisers in multiple genres with a focus on developing professional-level skills. Pre: 2816 for 3815; 3815 for 3816. (2H,2C)

3984: SPECIAL STUDY
Variable credit course.

4014: TOPICS IN ADVANCED ELECTROACOUSTIC RESEARCH
Rotating advanced research topics in electroacoustic music. Sonification, spatialization, algorithmic music, electronic music instrument design, digital performance ensembles, and advanced computer music composition. Repeatable with different content up to a maximum of 12 credit hours. Pre: 3066, 3164. (3H,3C)

4014H: TOPICS ADV ELECTROACOUSTIC RES
Rotating advanced research topics in electroacoustic music. Sonification, spatialization, algorithmic music, electronic music instrument design, digital performance ensembles, and advanced computer music composition. Repeatable with different content up to a maximum of 12 credit hours. Pre: 3066, 3164. (3H,3C)

4055-4056: MUSIC TECHNOLOGY SENIOR SEMINAR
Weekly seminars in music technology with group discussion of progress in current student projects, the current state of artistic and business practices in the recording industry, and guest lecturers drawn from

the professional world. Pre: 3056. (1H,1C)

4124: SPECIAL TOPICS IN MUSIC HISTORY AND LITERATURE
Specific, in depth study of one of several topics in music history and or literature. Pre: 3136. (3H,3C)

4204: REHEARSAL TECHNIQUES AND MATERIALS
Techniques and materials for rehearsing secondary school music performance ensembles. Pre: Instructor permission and successful completion of the sophomore music continuation exam. (3H,3C)

4514: ADVANCED INDIVIDUAL APPLIED VOICE
Individual instruction in voice at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2514.

4524: ADVANCED INDIVIDUAL APPLIED KEYBOARD
Individual instruction in keyboard at an advanced level. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2524.

4534: ADVANCED INDIVIDUAL APPLIED VIOLIN
Individual instruction in violin at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2534.

4544: ADVANCED INDIVIDUAL APPLIED VIOLA
Individual instruction in viola at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2544.

4554: ADVANCED INDIVIDUAL APPLIED CELLO
Individual instruction in cello at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2554.

4564: ADVANCED INDIVIDUAL APPLIED BASS
Individual instruction in bass at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2564.

4574: ADVANCED INDIVIDUAL APPLIED FLUTE
Individual instruction in flute at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2574.

4584: ADVANCED INDIVIDUAL APPLIED OBOE
Individual instruction in oboe at an advanced level. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2584.

4594: ADVANCED INDIVIDUAL APPLIED CLARINET
Individual instruction in clarinet at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2594.

4614: ADVANCED INDIVIDUAL APPLIED SAXOPHONE
Individual instruction in saxophone at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2614.

4624: ADVANCED INDIVIDUAL APPLIED BASSOON
Individual instruction in bassoon at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2624.

4634: ADVANCED INDIVIDUAL APPLIED HORN
Individual instruction in horn at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2634.

4644: ADVANCED INDIVIDUAL APPLIED TRUMPET
Individual instruction in trumpet at an advanced level. Majors only. May be repeated. Performance

continuation exam required. Variable credit course. Pre: 2644.

4654: ADVANCED INDIVIDUAL APPLIED TROMBONE
Individual instruction in trombone at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2654.

4664: ADVANCED INDIVIDUAL APPLIED BARITONE
Individual instruction in baritone at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2664.

4674: ADVANCED INDIVIDUAL APPLIED TUBA
Individual instruction in tuba at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2674.

4684: ADVANCED INDIVIDUAL APPLIED PERCUSSION
Individual instruction in percussion at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2684.

4714: ADVANCED INDIVIDUAL APPLIED HISTORICAL WIND INSTUMENTS
Individual instruction in historical wind instruments at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2714.

4724: ADVANCED INDIVIDUAL APPLIED HISTORICAL STRING INSTRUMENTS
Individual instruction in historical string instruments at an advanced level. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2724.

4734: ADVANCED INDIVIDUAL APPLIED COMPOSITION
Individual instruction in composition at an advanced level. Majors only. May be repeated. Performance continuation exam required. Variable credit course. Pre: 2734.

4744: ADVANCED INDIVIDUAL APPLIED CONDUCTING
Individual instruction in conducting at an advanced level. May be repeated. Consent required. Variable credit course. Pre: 3225, 3226.

4754: ADVANCED INDIVIDUAL APPLIED RECORDING
Individual instruction through directed experiential learning in music recording and production at an advanced level. Integration of critical listening, acoustics, audio recording, signal processing, audio mixing, and audio mastering with music theory and performance. An emphasis in hands-on exploratory research in the use of instruments, acoustics, microphones, recording, and production techniques combined with traditional methods and emerging technologies to capture and produce recordings in an artistic manner suitable for use in a senior portfolio. Permission required. May be repeated for a maximum of 12 hours. Variable credit course. Pre: 2754.

4764: ADVANCED INDIVIDUAL APPLIED ELECTROACOUSTICS
Individual instruction and completion of a major project in electroacoustic composition, performance, or research, at an advanced level. Repeatable up to three times for a maximum of 3 credit hours. Pre: 3064, 3066. (1H,1C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Myers-Lawson School of Construction (Construction Engineering and Management Program)

Director: Brian Kleiner
Program Coordinator: Robert Muir
Principle Faculty: A. Akanmu - CEM, Y. Beliveau - BC, K. Boyle - REAL, T. Bulbul - BC, J. de la Garza – CEE, M. Garvin - CEE, A. Graff - BC, D.P. Hindman - SBM, J. Iorio - MLSoC, F. Jazizadeh - CEE, A. Johnson – CEM, A. McCoy - BC, T. Mills - BC, R. Muir - CEM, F. Paige - CEE, A. Pearce - BC, G. Reichard - BC, N. Roofigari-Esfahan - BC, T. Shealy - CEE, D. Simmons - CEE, S. Sinha - CEE, W. Thabet - BC, P. Tarazaga - ME, and J. Yauger - BC

Web: **http://cem.mlsoc.vt.edu/**

Overview

The Myers-Lawson School of Construction offers students in the College of Engineering a Bachelor of Science Degree in Construction Engineering and Management. This degree is designed for students who wish to pursue a management or engineering career in the construction industry. The undergraduate program facilitates the development of critical technical, managerial and professional knowledge and skills required for entry into the construction industry or graduate studies. This body of knowledge includes the decision and optimization methods required to integrate and manage the resources essential to construction operations along with the skills that support the development of safe, ethical, socially responsible, and sustainable solutions for the built environment. The Construction Engineering and Management Program is accredited by the Engineering Accreditation Commission of ABET, **www.abet.org**.

Construction managers plan, direct, and coordinate construction projects, including the building of all types of residential, commercial, and industrial structures, roads, bridges, and other public works projects. Construction managers coordinate and supervise the construction process from the conceptual development stage through final construction, ensuring the project is completed within time and budget constraints and is compliant with building and safety codes and other regulations.

The focus of this degree is construction management with engineering and business management as additional focus areas of study. The degree retains an emphasis on engineering, with a focus on construction theory and applications, while providing students the opportunity to define the areas of business management they wish to study to complement their career goals.

Coursework (CEM xxxx) focuses on the specific knowledge, skills and abilities (KSA) critical for successful Construction Engineering and Management. Additional coursework is leveraged from the Via Department of Civil and Environmental Engineering, and the Department of Building Construction. The latter department is also in the School.

Consistent with the general program goal of facilitating development of student competence necessary for entry into the construction industry or graduate school, the School has developed the following program objectives:

- Within a few years of curriculum completion, graduates of the Construction Engineering and Management program should be able to combine skills gained through academic preparation and post-graduation experience to demonstrate:
    - The intellectual ability to critically assess, analyze, integrate and manage construction engineering problems.
    - An awareness of societal context and how those concerns affect their role as professional

engineers and in turn, how their role can enact beneficial change for society.
    - The values-based leadership and team building skills to effectively function in multi-disciplinary, multi-cultural, open-ended engineering activities in a professional and ethical manner, responding dynamically to the social and economic environment that impacts construction.
    - The communication skills to convey technical information to a variety of audiences that include all construction stakeholders, including the general public.
    - The ability and desire to engage in life-long learning in order to perpetually develop their construction engineering skills and professional knowledge, e.g. through graduate study, self-study, continuing education, licensure, mentoring, and leadership in their employment organizations, industry associations and professional societies
- Classroom instruction in the construction engineering and management program is reinforced by instructional laboratories, field trips and guest lectures by leading construction professionals. The program seeks to employ the latest educational technology and innovative teaching methods.
- Students in the School have the opportunity to participate in a summer internship program during which they may apply the concepts learned in the classroom in real world applications. The School encourages all students to participate in professional work experience prior to graduation, and all students are encouraged to pursue their FE and PE licenses.

Class Size Limitation

Currently, the program is not capped. The Industry has requested that CEM double in size due to industry demand for graduates.

The contact person for the undergraduate Construction Engineering and Management program is Dr. Robert Muir at (540) 231-9959 or rmuirjr@vt.edu. The CEM advisor is Ann Lee at (540) 231-5376 or annlee3@vt.edu.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students should choose the appropriate Checksheet based on their expected graduation date. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **https://registrar.vt.edu/graduation-multi-brief.html** for degree requirements.

Undergraduate Course Descriptions (BC)

1214: INTRODUCTION TO BUILDING CONSTRUCTION I
This is an introduction to the world of construction with an overview of the important areas of contracting and the inter-workings of the construction industry. Emphasis is placed on the theory and terminology of the construction industry supplemented with the graphical representation of construction documents and laboratory building experiments. (2H,3L,3C)

1224: INTRODUCTION TO BUILDING CONSTRUCTION II
Continuation of introduction to the world of construction with an overview of the important areas of contracting and the workings of the construction industry. Emphasis is placed on the application of theory,

processes and vocabulary of the construction industry supplemented with computer aided graphical representation of construction documents. Grade of C- or better required in prerequisite. Pre: 1214. (2H,3L,3C)

2014: CONSTRUCTION PRINCIPLES I
Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards. Pre: 1224. (2H,3L,3C)

2024: CONSTRUCTION PRINCIPLES II
Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression. Pre: 1224, 1214, 2014 or 4264. Co: 2064. (3H,3C)

2044: BUILDINGS & MATERIALS
Introduction to the theory and applications of building materials. Properties, composition, and characteristics of building materials with particular focus on ferrous and non ferrous metals, concrete, bricks and blocks, timber, glass and plastics. Emphasis on physical behavior of materials under load, including thermal loads, compatibility deformations and material behavior requirements, interaction among different materials, non- destructive/destructive methods for evaluation and testing of construction materials, basic analysis and design applications of major structural components. Pre: 2214 or CNST 2104 or CEM 2104. (2H,3L,3C)

2064: INTEGRATED CONSTRUCTION I
Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected project. Project cost impact of building code requirements. Emphasis on structural components of selected project. Pre: 2014. (3H,3C)

2094: BUILDING CONSTRUCTION SEMINAR
Exploration of current and relevant topics of inquiry within the construction domain, through engagement, service, and research. Articulates the complex interactions of stakeholders in construction by means of reflection on case studies, panel discussions, and seminars to establish the context, breadth, and impact that construction education shares within larger academic, professional, and societal communities. Can be repeated for a maximum of 3 credit hours. Pass/Fail only. (1H,1C)

2104: BUILDING EFFECTIVE CONSTRUCTION TEAMS
Introduction to tools and techniques to help build effective construction teams including building trust, managing conflict, communicating clear expectations and priorities, accountability, attention to results and commitment towards construction management team mission, embracing innovative change and ethics. Other topics include networking skills, time management tools and effective construction team-based negotiations. Pre: (1224 or 4264), (COMM 1016 or ENGL 1106). (3H,3C)

2114: INFORMATION TECHNOLOGY IN DESIGN AND CONSTRUCTION
Building delivery and project management improvements through the use of computer applications are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts the integrate design and construction. Pre: 1224 or CNST 2104 or CEM 2104. Co: 2014. (2H,3L,3C)

2214: WHY BUILDINGS STAND UP
Addresses why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Explores different types of soils and their strength properties. Pre: MATH 1225 or MATH 1025. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3014: BUILDING PHYSICS & ENVIRONMENTAL SYSTEMS
Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems. Pre: PHYS 2305. (2H,3L,3C)

3064: INTEGRATED CONSTRUCTION II
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project. Pre: 2064. (3H,3C)

3114: BUILDING SYSTEMS TECHNOLOGY
Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads. Pre: (2024 or CNST 2104 or CEM 2104), PHYS 2305. (2H,3L,3C)

3134 (CEM 3134) (CNST 3134): TEMPORARY STRUCTURES IN CONSTRUCTION
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts. Pre: (2044, 2024) or CEE 3684. (3H,3C)

3954: STUDY ABROAD
Study abroad in Spain. Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4024 (CEE 4014): ESTIMATING, PRODUCTION, AND COST ENGINEERING
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures. Pre: 2024, 2064. (3H,3C)

4064: INTEGRATED CONSTRUCTION III
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project. Pre: 3064. (3H,3C)

4114: BUILDING INFORMATION MODELING IN DESIGN AND CONSTRUCTION
Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard

for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming. Pre: 2114. (3H,3C)

4124: DIGITAL CONSTRUCTION & MANUFACTURING
Explore and experiment with construction from the perspective of digital information, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Tools like 3D scanners, 3D printers, CNC manufacturing techniques and others will be used in a lab setting intended to provide familiarity with these technologies and a sense of their benefits and limitations. Pre: 2114. (2H,3L,3C)

4164: PRODUCTION PLANNING AND PROCESS DESIGN FOR CONSTRUCTION
The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction. Pre: 3114, 3064. (3H,3C)

4264: FUNDAMENTALS OF CONSTRUCTION MANAGEMENT
Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing. (6H,6C)

4314: BUILDING PERFORMANCE & ENERGY MANAGEMENT
Fundamentals of building performance mandates for the built environment, practical means and methods for evaluating building performance metrics. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle. Pre: 3014. (2H,3L,3C)

4324: INNOVATION IN RESIDENTIAL CONSTRUCTION
Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry. Pre: 2024, 3114. (3H,3C)

4334: SUSTAINABLE BUILDING PERFORMANCE MANAGEMENT
Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning. Pre: 3064, 3014. (3H,3C)

4374: RESIDENTIAL HOUSING AND LAND DEVELOPMENT
Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing. Pre: 2064, 3064. Co: 4064. (3H,3C)

4434: CONSTRUCTION PRACTICE I
Business and construction practices related to operation of a construction company are studied.

Construction operation is examined as it relates construction, financial and personnel management. Project management topics studied in this course include permitting, site evaluations, design development and design phase considerations such as preliminary estimates and project constructability. Writing Intensive (WI) course. Pre: (2044, 3064) or 5264G or (5114, 5154) or CEM 2104. Co: 4064. (3H,3C)

4444: CONSTRUCTION PRACTICE II
This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals. Pre: 4434. (3H,3L,4C)

4754: INTERNSHIP
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (CEE)

1984: SPECIAL STUDY
Variable credit course.

2804: INTRODUCTION TO CIVIL AND ENVIRONMENTAL ENGINEERING
Overview of the specialty areas within the civil engineering profession, professional engineer licensing, and engineering ethics. Includes recognizing contemporary issues in civil engineering, civil engineering work in the surrounding community, and the impact of civil engineering solutions on society. Emphasizes successful personal business practices for civil engineering professionals, to include the fundamentals of effective oral, written, and visual communication skills for the Civil Engineer. Introduction to engineering library resources. A grade of C- or better required in prerequisite. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804 (3H,3C)

2814: CIVIL AND ENVIRONMENTAL ENGINEERING MEASUREMENTS
Introduction to various data measurement issues in civil and environmental engineering, including collection techniques, analysis, error, and statistical evaluation in all sub-disciplines. Spatial measurement topics include GPS, leveling, distance and angular measurement, mapping and topographic surveys, automated data collection, terrain models, earthwork methods, construction surveying, geodesy, and GIS. A grade of C- or better required in pre-requisites. Pre: BC students required to take the BC 1224 pre-requisite, BC and CEM students are exempt from corequisite CEE 2824. CEE students are required to take the ENGE 1216 pre-requisite. Pre: (ENGE 1114 or ENGE 1216 or ENGE 1414 or BC 1224), (MATH 1206 or MATH 1206H or MATH 1226). Co: 2824. (3H,3L,4C)

2824: CIVIL ENGINEERING DRAWINGS AND CAD
Introduction to the use of Computer-Aided Drafting (CAD) software in civil engineering, construction, and other land development projects. Interpretation of typical civil engineering drawings. Creation of land development plans, cross section and profile drawings, and detail drawings utilizing computer-aided design and drafting tools. Creation of two- and three- dimensional visualizations of civil engineering, construction, and other land development projects. (1H,1C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3014: CONSTRUCTION MANAGEMENT
Fundamental elements involved in managing construction projects. Management structure, construction contracts, equipment and labor productivity, scheduling, quality assurance, and cost control. Junior standing required. (2H,3L,3C)

3104: INTRODUCTION TO ENVIRONMENTAL ENGINEERING
Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations. A grade of C- or better required in pre-requisites. Pre: CHEM 1035, CHEM 1045, (MATH 1026 or MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024), (PHYS 2305 or PHYS 2205). (3H,3C)

3274: INTRODUCTION TO LAND DEVELOPMENT DESIGN
An introduction to the land development design process including site selection and feasibility, environmental considerations, utility layout, grading, stormwater management and integrating planning with the design of infrastructure to support residential and commercial development. A grade of C- or better in prerequisite. Pre: 2814, (2824 or ENGE 2824). (3H,3C)

3304: FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING
Introductory course in fluid mechanics. Includes concepts and measurements of fluid properties; computing hydrostatic and hydrodynamic forces on hydraulic structures; computing fluid pressures, discharges, and velocities; and determining energy losses in pipe flows. Course includes conducting hydraulic laboratory experiments and demonstrations, analyzing and interpreting collected data, and preparing technical laboratory reports. Emphasizes the fundamentals of effective interpersonal, written, and visual communication skills for technical civil engineering reports. A grade of C- or better in prerequisites. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804 Pre: ESM 2104, CEE 2804. (3H,2L,4C)

3314: WATER RESOURCES ENGINEERING
Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. A grade of C- or better required in prerequisite 3304. Design Lab/Studio. Pre: 3304. (3H,2L,4C)

3404: THEORY OF STRUCTURES
Fundamental tools and methods of structural analysis: moment-area, slope-deflection, force, and moment-distribution methods. Influence lines. Application to beams, trusses, and simple frames. A grade of C- or better required in pre-requisite ESM 2204. Pre: ESM 2204. (3H,3C)

3424: REINFORCED CONCRETE STRUCTURES I
Behavior and design of reinforced concrete members based on ultimate strength. Beams and slabs in flexure, shear and torsion, development of reinforcement. Columns with axial force plus bending, slenderness effects in columns. A grade of C- or better required in prerequisites. Pre: (3404, 3684) or BC 2044. (3H,3C)

3434: DESIGN OF STEEL STRUCTURES I
Behavior and design of structural steel members and steel-frame buildings, including simple and fixed connections. AISC specifications; elastic theory. Design members to resist tension, compression, bending, torsion; plate girders, composite beams. ESM 3054 may be taken in place of co-requisite CEE 3684. A grade of C- or better in prerequisite. Design Lab/Studio. Pre: (3404, 3684) or BC 2044. (3H,2L,4C)

3514: INTRODUCTION TO GEOTECHNICAL ENGINEERING
Engineering properties of soils including their descriptions and classifications, the effects of water, soil

strength and compressibility. Introduction to soil stabilization, earth pressures, slope stability, and foundations. A grade of C- or better required in pre-requisites GEOS 2104 and ESM 2204. Design Lab/Studio. Pre: ESM 2204, GEOS 2104. (3H,2L,4C)

3604: INTRODUCTION TO TRANSPORTATION ENGINEERING
Planning, design and operation of transportation systems with emphasis in multimodal transportation techniques and unified system engineering theories to analyze large scale transportation problems. Discussion of Intelligent Vehicle Highway Systems (IVHS) and hands on experience in computer models in transportation operations and planning. Interactions between transportation infrastructure and environmental engineering planning. Junior standing required. (3H,3C)

3684: CIVIL ENGINEERING MATERIALS
Characteristics of constituent materials and the design and behavior of portland cement and bituminous concrete mixtures with demonstrated laboratory experiments. A grade of C- or better required in prerequisites. Design Lab/Studio. Pre: CHEM 1035, CHEM 1045, ESM 2204, CEE 2814, GEOS 2104. (3H,2L,4C)

3804: COMPUTER APPLICATIONS FOR CIVIL AND ENVIRONMENTAL ENGINEERS
Introduction to computer applications in civil and environmental engineering. Integration of quantitative analysis for design, data management, computer programming and problem solving skills with computer tools and techniques. Topics include systems analysis, numerical methods, optimization, data mining, computer programming and data queries. Analysis and interpretation of a global data set. Pre: Junior Standing. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4014 (BC 4024): ESTIMATING, PRODUCTION, AND COST ENGINEERING
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures. A grade of C- or better required in pre-requisite 3014. Pre: 3014. (3H,3C)

4024: CONSTRUCTION CONTROL TECHNIQUES
Techniques used to plan, schedule, and control the Construction Process. Emphasizes manual and computer-based approaches. Focuses on an analytical approach towards the construction process whereby good technical methodologies and solutions are converted to reality through construction practices. A grade of C- or better required in prerequisite. Pre: 3014. (3H,3C)

4074: CONSTRUCTION ENGINEERING: MEANS AND METHODS
Construction means, methods, and equipment used to transform a particular design concept into a completed usable structure or facility. Selection and optimization of individual units as well as the systems needed to produce the required work to the required quality on time and on budget. A grade of C- or better required in prerequisite. Pre: 3014 or CEM 2104. (3H,3C)

4104: WATER AND WASTEWATER TREATMENT DESIGN
Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites. Pre: 3104, 3304. (3H,3C)

4114: FUNDAMENTALS OF PUBLIC HEALTH ENGINEERING
Public health engineering principles for protection against biological and chemical health hazards. Emphasis on major communicable diseases that plague mankind, organisms that cause them, routes of transmission, and engineering methods of control. Appropriate control methods for rural areas and developing countries. A grade of C- or better required in pre-requisite. Pre: 3104. (3H,3C)

4134: ENVIRONMENTAL SUSTAINABILITY - A SYSTEMS APPROACH
Quantitative methods to evaluate environmental sustainability using a sytems approach. Sustainability assessment frameworks, oreintors and indicators, indicators of sustainable development, green-house gas emissions, renewable energy systems, whole-system design, economic systems and input-outpur techniques, system dynamics models, emergence and agent-based models. Class project requiring integration of environmental, economic and social systems using system dynamics and agent-based models. Senior Standing. Pre: MATH 2214. (3H,3C)

4144: AIR RESOURCES ENGINEERING
Effects, regulation, sources, and control of air pollution. Application of engineering calculations and models to estimate emissions, predict pollutant concentrations, and design pollution control equipment. Senior standing required. A grade of C- or better required in prerequisites. Pre: 3104 or ENGR 3124 or GEOS 3114 or ENSC 3634. (3H,3C)

4174: SOLID AND HAZARDOUS WASTE MANAGEMENT
Introduction to the problems, regulations and techniques associated with the management of solid and hazardous waste. Composition, volume and characterization of the wastes. Design of collection and disposal systems, including landfills, solidification/stabilization and incineration. A grade of C- or better required in pre-requisite 3104. Pre: 3104. (3H,3C)

4254: MUNICIPAL ENGINEERING
An introduction to the field of municipal engineering. Infrastructure, capital projects, financing, sustainability, disaster planning and response, and plan review for development projects. Senior standing required. (3H,3C)

4264: SUSTAINABLE LAND DEVELOPMENT
An introduction to the modern techniques for developing land while maintaining a focus on long-term sustainability. Topics include site layout, stormwater impact, air quality and microclimate, living resources, LEED and EarthCraft development standards. Pre-requisite: Senior Standing required (3H,3C)

4274: LAND DEVELOPMENT DESIGN
Overview of land development projects including factors, construction practices, legal issues, and government policies. Design project includes feasibility study, engineering evaluation of site, and layout design of lots, buildings, streets, sewers, etc. Interactive graphics and automated drafting. Senior standing in Civil Engineering required. A grade of C- or better required in prerequisite. Pre: 3274. (2H,3L,3C)

4284: ADVANCED LAND DEVELOPMENT DESIGN
Advanced course in land development design focusing on site grading and parking, stormwater management, and erosion control. Reviews project design criteria and applicable municipal and state guidelines. Uses CAD software for design and deliverables. Senior/Graduate standing required. A grade of C- or better required in pre-requisites. Pre: 3274. Co: 4274. (3H,3C)

4304: HYDROLOGY
Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in pre-requisite. Pre: 3304. (3H,3C)

4314: GROUNDWATER RESOURCES
Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in pre-requisite 3304. Pre: 3304. (3H,3C)

4324: OPEN CHANNEL FLOW
Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow. Pre: 3314. (3H,3C)

4334: HYDRAULIC STRUCTURES
Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models. A grade of C- or better required in pre-requisite 3314. Pre: 3314. (3H,3C)

4344: WATER RESOURCES PLANNING
Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required. (3H,3C)

4354: ENVIRONMENTAL HYDROLOGY
Overall view of pollutants movements in surface waters, with emphasis on the role of various hydrologic processes. Natural and constructed wetlands and their use for water quality control. Fundamentals of river hydraulics. Design of flood control channels. Environmental consequences of various types of hydraulic systems. Mitigation, enhancement, and restoration techniques. A grade of C- or better required in pre-requisites 3104 and 3314. Pre: 3104, 3314. (3H,3C)

4384: COASTAL ENGINEERING
Basic wave mechanics principles, surf-zone processes, littoral and sediment processes, shoreline features, astronomical tides, coastal hazards, and functional design of coastal structures. Field trips. Pre: C- or better in 3304. Pre: 3304. (3H,3C)

4404: COMPUTER ANALYSIS OF STRUCTURES I
Formulation of matrix displacement method in a form suitable for program development. Application to trusses and frames. Incorporation of special features such as symmetry, internal releases, support settlements, and influence lines. Initiation of program development. Use of existing programs on the personal computer. A grade of C- or better required in pre-requisite 3404. Pre: 3404. (3H,3C)

4454: MASONRY STRUCTURAL DESIGN
Masonry materials, material testing, material specifications. Structural behavior and design of masonry elements (walls, beams, and columns) and systems used in structures. Construction techniques and the details of masonry construction. Building codes relating to analysis and design of masonry structures. A grade of C- or better required in pre-requisites 3424 and 3684. Pre: 3684, 3424. (3H,3C)

4514: METHODS IN GEOTECHNICAL ENGINEERING
Principles and techniques for characterizing earth materials (soil and rock) for civil engineering projects in various regional environments; with emphasis on the interdisciplinary approach to field exploration and site description through soil mechanics theory, geologic correlations, geophysical methods, in site testing and sampling. A grade of C- or better required in pre-requisite 3514. Pre: 3514. (3H,3C)

4534: EARTH PRESSURES AND FOUNDATION STRUCTURES
Earth pressure theories and their applications to the design of retaining structures, anchors, and excavation bracing. Bearing capacity and settlement of shallow foundations. Types and capacity of deep foundations. A grade of C- or better in pre-requisite 3514. Pre: 3514. (3H,3C)

4544: DESIGN OF EARTH STRUCTURES
Application of geotechnical engineering principles in the design and construction of earth structures. Subsurface models, shear strength of soil, slope stability, earth fills, earth retention, ground improvement, sustainability considerations, geotechnical reporting. Team-based design project. C- or better in 3514. Pre: 3514. (3H,3C)

4554: NATURAL DISASTER MITIGATION AND RECOVERY
Causes, mechanics, classifications, and forces associated with tornadoes, hurricanes, floods, earthquakes, and landslides. Resistance evaluation for existing ground, facilities and structures. Hazard-resistant design of new facilities. Risk and reliability assessment and decision analysis. Strategies and designs for natural disaster risk mitigation. Emergency response for protection of life and property and restoration of lifelines. Includes an interdisciplinary team project. Prerequisite: Senior Standing Required (3H,3C)

4564: INTRODUCTION TO COASTAL AND MARINE GEOTECHNICS
Geotechnical aspects of coastal and marine engineering. Introduction to the coastal zone as a working environment. In-situ geotechnical methods and complementary techniques for investigation. Survey strategies. Local field trips for demonstrating methods, practice and design. A grade of C- or better is required in prerequisite 3514. Pre: 3514. (3H,3C)

4604: TRAFFIC ENGINEERING
Study of traffic and parking characteristics; application of traffic control devices; principles and techniques used to improve the efficiency and safety of traffic flow systems. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4614: ADVANCED STRUCTURAL CONCRETES
Fundamental properties and the physical and chemical aspects of the structure of Portland cement concretes. Emphasis placed on environmental performance aspects and the application of studies of concrete performance under various exposure conditions. A grade of C- or better required in pre-requisite 3684. Pre: 3684 or BC 2044. (3H,3C)

4624: PLANNING TRANSPORTATION FACILITIES
Transportation planning process; urban and regional studies, surveys, data analysis, model development and testing; transportation management, administration, finance, system evaluation, implementation, and integration. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4634: INFRASTRUCTURE CONDITION ASSESSMENT
Infrastructure components and assessment needs; physical and chemical properties of construction materials; deterioration causes, assessment methods, nondestructive evaluation techniques, infrastructure management systems, performance models, service-life-cycle estimates. A grade of C- or better required in pre-requisite 3684. Pre: 3684. (3H,3C)

4644: TRAFFIC SIGNAL SYSTEM OPERATION AND CONTROL
Traffic signal system control, with emphasis in arterial operation. Signal system design and operations, traffic simulation techniques, advanced traffic control strategies, and incorporation of surface street systems into Intelligent Transportation Systems (ITS). Hands-on experience in signal system software and hardware. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4654: GEOMETRIC DESIGN OF HIGHWAYS
Functional design of highways; curves, intersections, interchanges, drainage, and other features involved in highway safety and traffic efficiency. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4664: PAVEMENT DESIGN
Principles underlying methods for the design of various elements of flexible and rigid pavements for highways and airports; climate and traffic effects; pavement management systems. A grade of C- or better required in pre-requisite 3684. Pre: 3684. (3H,3C)

4674: AIRPORT PLANNING AND DESIGN
Airport planning and economic justification, site selection, configuration, development and design of terminal areas, demand forecasting, access, traffic control. A grade of C- or better required in pre-requisite 3604. Pre: 3604. (3H,3C)

4684: TRANSPORTATION SAFETY
Basic principles associated with transportation safety related to humans, vehicles and infrastructure as well as principles of design for safety and practices of empirical evaluation of safety. Principles and practices of accident investigation and injury epidemiology as well as safeguards and control practices. A grade of C- or better required in prerequisite. Pre: 3604. (3H,3C)

4694: FREIGHT OPERATIONS
Introduction to the operation of modal and intermodal freight facilities. Impact of goods movement on the multi-modal transportation system. Role of privately owned and operated goods movement on public sector transportation operations, management, and decision making. Communication of impacts. Pre:

3604. (3H,3C)

4804: PROFESSIONAL AND LEGAL ISSUES IN CIVIL ENGINEERING
An overview of civil engineering professional practice, including business etiquette, professional development, leadership, and lifelong learning. Emphasizes the importance of registration for civil engineers. Compares and contrasts common project delivery methods, processes, key players, and management topics for the design and construction industry. Incorporates analyses of legal and ethical aspects of civil engineering practice. Analyzes contemporary issues and public policies that impact the civil engineering profession, and the impacts of civil engineering solutions on society. Emphasizes effective written, oral, and visual professional communication for the civil engineering professional. A grade of C- or better in prerequisite. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804 Pre: 2804. Co: 3304. (3H,3C)

4814: RISK AND RELIABILITY ANALYSIS IN CIVIL AND ENVIRONMENTAL ENGINEERING
Risk assessment and reliability analysis as applied to civil engineering applications. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Application of probability and statistics to performance analysis. Development of probabilistic engineering safety assessments. Pre: 3804. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (CEM)

1974: INDEPENDENT STUDY
Variable credit course.

2104: INTRODUCTION TO CONSTRUCTION ENGINEERING MANAGEMENT
Overview of the construction engineering and management profession specialty areas. Introduction to the undergraduate program of study. Emphasis on the fundamentals of good oral and written communication skills. Professionalism, ethics and legal issues relating to the industry. Emphasis on contemporary issues facing the industry. Introduction to engineering library resources. (2H,2C)

2984: SPECIAL STUDY
Variable credit course.

3024: CONSTRUCTION ESTIMATING AND SCHEDULING
Introduction to estimating and scheduling of construction operations using construction documents. Quantity takeoff, resource and crew enumeration, network logic, activity durations, Critical Path Method (CPM) and Location-Based Management System (LBMS). Bid assembly with markups. Construction decisions based on ethical principles. A grade of C- or better is required in prerequisite. Pre: 2104. (3H,3C)

3064: INTRO TO LEAN CONSTRUCTION
Introduction to Lean Construction thinking, principles, and practices, definitions, history, theory, and fundamentals related to project production systems. Operating system, organization practices, commercial terms. Pull planning and Last Planner System, teh Big Room concept, and Integrated Form of Agreement (IFOA). Conventional Lean practices A3 problem solving, 5 Whys Root Cause Analysis, and 5s Methadology. Continuous improvement, respect for people, elimination of waste, reducing variability

and increasing plan reliability. Pre: 2104. (3H,3C)

3074: GLOBAL DESIGN AND CONSTRUCTION FOR SUSTAINABLE DEVELOPMENT
A collaborative approach for applying engineering systems and design to global issues. Design, engineering, and construction focused on social responsibility in the global village. Multi-disciplinary teamwork requiring identification of client needs and design considerations, development of site layouts, selection of resources, management of schedule, cost, materials, personnel, quality, and jobsite safety. Applied conflict handling skills and self-reflection on social responsibility, service, intercultural global awareness, and evaluating the success of sustainable projects. May be repeated one time with different content for a maximum of six credits. Multi-day field trip required. Pre: Junior Standing. (3H,3C)

3084: CONSTRUCTION ECONOMY
Fundamentals of engineering economics, accounting, finance, and entrepreneurship in the construction industry. Construction financial management, accounting for financial resources, cost, profit, cash flow management, and financial decision-making. Accounting, financial risk estimation, and generation of financial statements in the context of construction industries. Construction company creation, business plan development. Assessment of construction project delivery methods, and impacts of retainage, bonding, and taxation. Pre: 2104 or BC 2024. (3H,3C)

3134 (BC 3134): TEMPORARY STRUCTURES
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts. Pre: (BC 2044, BC 2024) or CEE 3684. (3H,3C)

3154: SMART CONSTRUCTION
Introduction to smart construction, definitions, principles and practices. Exploration of inefficiencies associated with the traditional approaches to construction. Intelligence requirements of the building lifecycle. Smart planning and contracting practices, and facilitating technologies. Smart design principles, techniques, technologies, strategies for involving down-stream stakeholders in the design of buildings for constructability and maintainability. Overview of digital infrastructure, types, selection and role in integrating the design and construction phases. Pre: 2104, BC 2114. (3H,3C)

3164: CONSTRUCTION HEALTH AND SAFETY
Introduction to fundamentals of Occupational Health and Safety (OHS) for the construction industry. History of OHS regulation and specific governmental regulations, standards and laws. Health, safety, and environmental hazards identification. Methods of quantifying exposure and estimating risk. Design and prioritization of control solutions to mitigate hazards. Contemporary issues and theoretical frameworks in the field of OHS management relevant to the industry. Prevention through Design, behavior-based safety, different construction project delivery methods, safety climate and culture, control banding, and systems safety. Pre: CNST 2104 or CEM 2104. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4024: CONSTRUCTION LAW AND CONTRACT ADMINISTRATION
Application of contract law, torts, and statutory law in construction. Legal context, parties, interpreting contracts and specifications, contract changes, differing site conditions, delays, disruptions, and acceleration. Dispute avoidance and resolution. Ethics and risk management. Pre: Senior Standing. (3H,3C)

4314 (SBIO 4314): DESIGN OF WOOD STRUCTURES
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls. Pre: SBIO 3314 or CEE 3404. (3H,3C)

4445-4446: CEM CAPSTONE

4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing. Pre: BC 3064 for 4445; 4445 for 4446. Co: BC 4064 for 4445. (3H,3C)

4964: FIELD WORK/PRACTICUM
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Nanoscience

Division Leader: R. Heflin
Program Manager: C. Conley
Principle Faculty: D. Capelluto, H. Dorn, S. Emori, A. Esker, C. Finkielstein, G. Khodaparast, G. Liu, T. Long, B. Magill, J. Matson, F. M. Michel, A. Morris, V. Nguyen, K. Park, H. Robinson, and C. Tian

Web: **www.ais.science.vt.edu/programs/Nanoscience.html**

Overview

The Nanoscience (NANO) program is a joint effort of the departments of Biological Sciences, Chemistry, Geosciences, and Physics. It resides in, and is organized as a division of, the College of Science's Academy of Integrated Science.

Nanoscience, the fundamental study of materials and structures whose size is on the nanometer scale, lies at the very foundation of our world. A nanometer is simply a billionth of a meter, and a typical atom is about 1/10th of a nanometer in size. At this length scale, atoms and molecules follow the laws of quantum physics, and the processes of life (for example, DNA and proteins are naturally-occurring nanoscale materials) and the properties of materials emerge from them. Due to a combination of profound theoretical insights, advances in scientific instrumentation, and massive computing power, we are now capable of imaging and steering single atoms with unprecedented precision, opening a window toward a world in which materials, chemical compounds, devices, and even small organisms can be built atom by

atom and molecule by molecule, tailored toward desired properties and applications. At present, we are only at the dawn of this nanoscience revolution.

Nanoscience courses prepare undergraduates for productive, exciting careers in emerging nanoscale industries. Degree recipients from this program will be ready to contribute to and lead cutting-edge corporate research and development in some of the most important and profitable industries in the world, including information technology, communications, drug development, imaging, and environmental technology.

Bachelor of Science in Nanoscience

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Nanoscience Majors

- Nanoscience B.S. Nanoscience (NANO)
- Nanoscience B.S. Nanoscience (NMED)

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways to General Education) (see "**Academic Policies**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Nanoscience can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Minor in Nanoscience

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for requirements toward a minor in Nanoscience.

Undergraduate Course Descriptions (NANO)

1015-1016: INTRODUCTION TO NANOSCIENCE
Introduction to the interdisciplinary field of nanoscience with perspectives from biology, geoscience, computational science, chemistry, and physics. 1015: Historical perspectives; public perception; economic impact, nanoscience in biology and environment; quantum physics principles; characterization tools; mathematical modeling. 1016: Nanofabrication methods; nanoparticle synthesis and characterization; self-assembly; applications in medicine, electronics, and energy; sustainability. Pre: 1015 for 1016 (3H,3C)

2024: QUANTUM PHYSICS OF NANOSTRUCTURES

Introduction to the quantum physics which governs the properties of matter at the nanoscale. Specific topics include: Quantization, wave-particle duality, and Schrodinger equation, with applications to the hydrogen atom, periodic crystals, and nanostructures; electron spin, spintronics, and quantum statistical physics. Pre: 1016, (MATH 1226 or MATH 1026), (PHYS 2306 or PHYS 2206). (3H,3L,4C)

2114: NANOSCIENCE RESEARCH SEMINAR
Readings and discussion of current research areas of nanoscience and nanotechnology including nanofabrication, scanning probe techniques, functional nanomaterials, molecular engineering, bionanotechnology and nanomedicine. Presentations by guest nanoscience faculty on their research activities. Pre: 1016. (1H,1C)

2124: NANOSCIENCE RESEARCH ROTATIONS
Research experiences in campus nanoscience research laboratories. Rotation through three to four laboratories to obtain detailed understanding and hands-on experience of specific research projects. Pre: 2114. (6L,2C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3015-3016: NANOSCALE SYNTHESIS, FABRICATION, AND CHARACTERIZATION
Tools for synthesis, fabrication and characterization of nanomaterials and nanostructures including organic and polymer synthesis, self-assembly, and top-down fabrication as well as methods for identifying their structure and electronic, optical, and thermal properties. 3015: Multiphase macromolecules; electron and scanning probe microscopies; fullerenes, graphene, and nanotubes; optical and electron spectroscopies, thermal analysis; quantum dots and metallic nanoparticles. 3016: Nucleic acid self-assembly; polyelectrolyte complexes; dynamic light scattering and zeta potential; electrostatic self-assembly; self-assembled monolayers; photolithography; electron and ion beam lithography; microcontact printing and nanoimprint lithography. Pre: (CHEM 2514 or CHEM 2535 or CHEM 2565), (NANO 2024 or PHYS 3324) for 3015; 3015, (CHEM 2514 or CHEM 2536 or CHEM 2566) for 3016. (3H,3L,4C)

3114: PROFESSIONAL DISSEMINATION OF NANOSCIENCE RESEARCH
Technical skills for dissemination of nanoscience research. Effective use of the nanoscience and nanotechnology literature, use of technologies that support collaborative oral and written communication. Key elements of effective journal publications and conference presentations. Pre: 2114. (1H,1C)

3124: NANOSCIENCE AND THE ENVIRONMENT
Introduction to the connections between nanoscience, nanotechnology, and the environment. Overview of environmental science, why environmental issues are relevant to industry/business/research, naturally-occurring nanomaterials and their roles on Earth, and what is currently known about how manufactured and incidental nanomaterials interact with the atmosphere, hydrosphere, pedosphere, and biosphere. Pre: 1016, (BIOL 2104 or BIOL 2124), (CHEM 1036 or CHEM 1056). (3H,3C)

4124: ADVANCED NANOMATERIALS AND DEVICES
Overview of types of nanomaterials such as nanoparticles, quantum dots, fullerenes, carbon nanotubes, nanowires, graphene, and ultra-thin films. Special nanocomposite materials. Electronic, optical, magnetic, and transport properties of nanomaterials. Interactions between nanomaterials and substrates or interfaces. Applications of nanomaterials for electronics, magnetic storage, and energy-efficient devices. Pre: 3016, MATH 2214, (NANO 2024 or PHYS 3324). (3H,3C)

4314: NANOMEDICINE
Medical use of nanomaterials including basic, translational, and clinical research. Nanomedical approaches to drug delivery. Diagnostic sensors. Use of nanomedical tools over conventional techniques to treat diseases/disorders. Technical issues associated with medical applications. Bioavailability of

nanotherapies. Use of quantum dots for imaging. Ethical concerns and economic benefits associated with nanomedicine. Pre: 3016, (BIOL 2104 or BIOL 2124). (3H,3L,4C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

2019-2020 Undergraduate Course Catalog and Academic Policies

Neuroscience

Executive Director: H. Sontheimer
Associate Professors: M. A. Cline, S. M. Clinton, E. R. Gilbert, and M. L. Olsen
Assistant Professors: J.M. Bowers, M. Buczynski, S. Campbell, D. English, G. Hodes, T. Jarome, I. Kimbrough, L. Ni, K. Phillips, A. Pickrell, S. Robel, K. Sewall, C. Thompson, and S. Vijayan
Affiliated Faculty: L. Apfel, S. Ball, M. A. Bell, L. Bergamasco, A.S. Bertke, D. Bevan, W. Bickel, R. Blieszner, G. Cao, P. Carlier, A. Cate, J. Chappell, P. Chiu, B. Corl, B. Costa, R. Davalos, S. DeLuca, M. Denbow, N. Dervisis, R. Diana, H. Dorn, Z. Elias, X. Feng, C. Finkielstein, M. Fox, C. Frank, J. Fraser, M. Friedlander, B. Friedman, D. Good, R. Gourdie, D. Harrison, G. Howes, R. Jensen, X. Jia, B. Johnson, J. Jones, B. S. Jortner, D. Kelly, B. King-Casas, B. Klein, S. Kojima, S. Laconte, Y. W. Lee, L. Li, C. Logan, E. Marvin, T. Milam, R. Montague, I. Moore, A. Morozov, K. Mukherjee, N. Nanthakumar, M. Orr, R. Panneton, B. Patel, J. Phillips, J. Prickett, S. Ramey, K. Roberto, C. Rogers, J. Rossmeisl Jr., W. Santos, A. Scarpa, Z. Sheng, G. Simonds, D. J. Slade, A. Smith, M. Theus, P. VandeVord, S. Verbridge, E. Weaver, M. Witcher, C. Wyatt, D. Xie, B. Xu, and D. Zallen
Instructors: Z. Fu
Undergraduate Advisor: S. Carl and A. Laib

Web: **www.neuroscience.vt.edu**

COLLEGE OF SCIENCE
SCHOOL OF NEUROSCIENCE
VIRGINIA TECH

Overview

The Neuroscience degree draws on faculty and resources from many departments across the campus including but not limited to Animal & Poultry Science, Biological Sciences, Chemistry, Economics, Engineering, Mathematics, Physics, Psychology and Statistics. Graduates of this interdisciplinary program will be proficient in integrating neurogenetics, cellular and molecular neuroscience, neurophysiology, cognitive, computational and systems neuroscience.

The Neuroscience B.S. promotes the advancement and integration of knowledge about the brain and the entire central nervous system, and how they react to and are affected by the vast milieu of stimuli they encounter. The degree program is built on collaborative work and education of students in the classroom, and on the student interactions with researchers and practitioners, providing an unparalleled breadth of neuroscience education at the undergraduate level.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Neuroscience Majors

- Neuroscience B.S. Clinical Neuroscience (CNEU)
- Neuroscience B.S. Cognitive and Behavioral Neuroscience (CBNU)
- Neuroscience B.S. Computational and Systems Neuroscience (CSNU)
- Neuroscience B.S. Experimental Neuroscience (CNEU)

Transfer students should contact the department early, preferably one full semester prior to entrance. This procedure will allow a thorough evaluation of transfer credits and correct placement.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**")

and toward the degree.

Satisfactory progress requirements toward the B.S. in Neuroscience can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (NEUR)

1004: NEUROSCIENCE ORIENTATION SEMINAR
An introduction to the field of neuroscience, and academic and career planning for neuroscience majors. Exposure to areas of practice and research, and opportunities for education, training and employment in this field. (1H,1C)

1984: SPECIAL STUDY
Variable credit course.

2014H: HONORS FUNDAMENTALS OF NEUROSCIENCE
Fundamental concepts in neuroscience including nervous system organization, signaling within neurons and across synapses, sensory and motor systems, emotion, memory, and language. Major neurological disorders and animal models used in neuroscience. Restricted to non-neuroscience majors in the Honors College. Pre: BIOL 1105. (3H,3C)

2025-2026 (APSC 2025-2026): INTRODUCTION TO NEUROSCIENCE
Introduction to the fundamental principles of neuroscience. 2025: Structure and function of central nervous system in humans and other animals, signal processing and transmission, development of neural and brain circuits, encoding and transmission of sensory and perceptual information, motor control/movement. 2026: Complex brain processes including learning, memory, emotion, decision making, social behavior, and mental and functioning. Pre: BIOL 1005 or BIOL 1105 or ISC 1105 for 2025; 2025 for 2026. (3H,3C)

2035-2036: NEUROSCIENCE LABORATORY
Organization and function of the nervous system. 2035: neuroanatomy, microscopy, intracellular stimulation, extracellular recording, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes. Co: 2025 for 2035; 2026 for 2036. (3L,1C)

2464: NEUROSCIENCE AND SOCIETY
Social, ethical, and legal issues faced by human societies from the perspective of neuroscience. Broader questions about how neuroscience informs education, medicine, law, and public health. Research in neuroscience as it relates to issues of mental health, poverty, stress, and politics. (3H,3C)

2554: EXPERIMENTAL NEUROSCIENCE
Introduction to the conceptual framework of contemporary experimental methods and practices in neuroscience research. Exploration of experimental techniques including electrophysiology, advanced imaging, immunohistochemistry, transgenic animal models, and behavioral assays. Includes face-to-face interaction with various research faculty to explore research methods in practice and discuss current research and expertise. Pre: 2025, 2035. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3044: CELLULAR AND MOLECULAR NEUROSCIENCE

Fundamental principles of cellular and molecular neuroscience. Methods to study neurochemisty and neurobiology, theoretical and practical issues of relating cellular/molecular structures and functions to higher-level nervous system functioning, and current understanding of cellular/molecular bases of nervous system disorders. Pre: 2026, (CHEM 1036 or ISC 2105). (3H,3C)

3064: EDUCATIONAL NEUROSCIENCE
The conceptual framework of neuroscience of learning and instruction. Methods for studying mind and brain functions and their role in academic success and failure in educational settings. Theoretical and practical issues regarding pedagogy and assessment. Pre: 2026. (3H,3C)

3084: COGNITIVE NEUROSCIENCE
Concepts in cognitive neuroscience. Methods available to study brain and nervous system function, theoretical and practical issues of relating mental functions to biological brain functions. Overview of current understanding of the neural bases of various mental functions (e.g., memory, attention, emotion, decision making). Pre: 2026. (3H,3C)

3144: MECHANISMS OF LEARNING AND MEMORY
Foundation of social interactions in human and non-human: ability to learn and memorize locations, situations, individuals, facts and tasks forms. Cellular and molecular mechanism underlying learning and memory and model systems. Approaches to these processes along with diseases presenting with learning and memory deficits in humans. Pre: 2026. (3H,3C)

3234: THE ARTIFICIAL BRAIN
Introduction to brain-machine interactions and computer models of neural systems. Exploration of brain-computer interface applications, biophysically-based computational models of the brain, and computer neural networks in the context of artificial intelligence. Emphasis on the capabilities and limitations of neural networks and how they inform our understanding of the human brain. Discussion of societal impact and ethical considerations. Pre: 2026, (MATH 1026 or MATH 1226). (3H,3C)

3554: NEUROSCIENCE RESEARCH AND PRACTICAL EXPERIENCE
Integration of the interdisciplinary fields of neuroscience: includes the conceptual frameworks and theories of neuroscience spanning molecules to behavior, the methods available to study nervous system structure and function from molecules to behavior, theoretical and practical issues of linking these lower-levels structures and processes to higher-level neurological and psychological functions, and the latest applications and technologies for translating neuroscience into more effective interventions and treatments. Practical experience includes literature review research and writing, data analysis and interpretation, written and oral presentation, and site-specific training. Pre: 2026. (3H,3C)

3774: NEUROENDOCRINOLOGY
Comprehensive survey of the interrelationships between human neural and endocrine systems. Regulatory mechanisms for neural control of hormone secretions, peripheral hormone action on physiological processes, and hormonal influences on behavior. Pre: 2025. (3H,3C)

3844: COMPUTATIONAL NEUROSCIENCE AND NEURAL ENGINEERING
Introduction to computational and systems neuroscience. Data analysis and signal processing techniques for neural data. Neural modeling to include mean field models, Hodgkin-Huxley models, integrate and fire models. Neural engineering and brain machine interface (BMI) applications. Pre: MATH 1226. (3H,3C)

3914: NEUROSCIENCE OF DRUG ADDICTION
History of addiction as a chronic, relapsing brain disease. Neurocircuitry and molecular basis of the brain affected by common drugs of abuse. Overview of the use, abuse, liability, and psychotherapeutic effects of drugs on humans. Common classes of drug abuse: alcohol, sedatives, tobacco/ nicotine, opiods, cannabinoids, psychostimulants, psychedelics, steroids, anti-anxiety, antidepressants, and antipsychotics. Animal models in drug addiction studies. Current and future pharmacotherapeutics for drug addiction treatment and ethical considerations of treatments. Pre: 2025, 2026. (3H,3C)

3944: WAR AND THE BRAIN
Neurological and psychological factors associated with military and war. Neuroscientific basis of decision

making, mental resilience, and cognitive enhancement. Etiology and treatment of brain injuries sustained during war including post-traumatic stress disorder, traumatic brain injury, and chemical warfare. Neurotechnological advances that shape soldiers and warfare. Ethical considerations of "militarization" of neuroscience. Pre: 2026. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4034: DISEASES OF THE NERVOUS SYSTEM
Common brain and Central Nervous System (CNS) disorders ranging from trauma to autism. Genetic, molecules and cellular changes in disease. Therapeutic implications and development of novel drugs. Challenges in drug discovery and implementation of personalized medicine. Ethical issues regarding genetic findings. Pre: 2026, 3044. (3H,3C)

4044: NEUROSCIENCE SENIOR SEMINAR
Integration of methods and results from cutting-edge interdisciplinary neuroscience research; theoretical and practical issues when linking molecular/cellular structures and processes to higher-level neurological and psychological functions. May be repeated twice with different content for a maximum of 9 credits. Pre: 3044 or 3084. (3H,3C)

4084: DEVELOPMENTAL COGNITIVE NEUROSCIENCE
Concepts in developmental cognitive neuroscience. Methods available to study development of brain and nervous system function. Relating developmental change in mental functions to development of biological brain functions. Advancements in research and practice regarding developmental basis of neurological and mental functions (e.g., memory, attention, emotion). Pre: 3084. (3H,3C)

4314: GENETICS IN NEUROSCIENCE
Concepts of classical, modern genetics and epigenetics as it relates to neuroscience. Practical applications including genome-wide association (GWAS), next-generation sequencing, epigenetics, genome editing and screening methods. Use of model organisms in neurogenetic disorders research. Relationship of genetics and its influences on theoretical and practical issues in neurological and neurodevelopmental disorders. Personalized medicine in neurodevelopmental and neurogenetic disorders. Pre: 3044. (3H,3C)

4364: NEUROSCIENCE OF LANGUAGE AND COMMUNICATION DISORDERS
Concepts of language as distinctive human behavior and central to social life. Neural underpinnings of humans’ ability to speak and understand language. Neurologic processing of language comprehension and production in healthy and language-impaired individuals. Auditory and visual word recognition, reading, understanding speech, representation of word meaning, language production, and bilingualism. Neuroethology of communication and neurological disorders of communication: dyslexia, stuttering, and aphasia. Theoretical issues in language processing and converging evidence from different techniques and animal models addressing these issues. Pre: 2026. (3H,3C)

4454 (ECON 4454) (PSYC 4454): NEUROECONOMICS
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business. Pre: 2026 or ECON 3104. (3H,3C)

4514: NEUROIMMUNOLOGY
Immune system and assorted roles in psychiatric and neurological disorders. Details of cell type, functions and signaling of the peripheral and central immune system, and sympathetic nervous system. Cross-talk between the brain and immune system across the blood brain barrier and circumventricular organs. Treatment options for autoimmune diseases and psychopathy. Pre: 3044. (3H,3C)

4544: SYNAPTIC STRUCTURE AND FUNCTION
Synapse morphology and function, central versus peripheral synapses, site of action of many therapeutic drugs and substances of abuse, synaptic pruning and failure. Changes in synaptic structure and function during development and in diseases. Pre: 2026. (3H,3C)

4594: CLINICAL NEUROSCIENCE IN PRACTICE
Clinical approaches to diagnose and treat neurological disorders. Diseases include stroke, trauma, brain tumors, psychiatric illnesses, and epilepsy. Clinical experience includes diagnostic procedures, radiological techniques, and surgical procedures in operating room. Patient rounding, follow-up, and outcomes. Medical emergencies and appropriate professional responses. Ethical issues regarding health care, disparity, life and death decisions. Medical profession exploration. Pre: 4034. (3H,3C)

4814: NUTRITIONAL NEUROSCIENCE
Concepts in nutritional aspects of neuroscience. Energy metabolism in central nervous system and brain regulating ingestive behavior. Communication with peripheral organs, regulation of whole body energy homeostasis, brain physiology and pathology on molecular and cellular level. Role of appetite neurocircuitry in formulation of practical solutions to societal problems such as nutrition, eating disorders, and obesity. Pre: 3044. (3H,3C)

4914: DRUG DEVELOPMENT IN NEUROSCIENCE
Current approaches and pitfalls for developing therapeutics for treating disorders of the central nervous system (CNS). Theoretical issues and practical applications targeting identification, high-throughput screening, pharmacokinetics and pharmacodynamics, preclinical testing, clinical trials, and the FDA approval process. Ethical implications for drug development and testing. Pre: 3044 or 3914. (3H,3C)

4964: FIELD WORK
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Philosophy

Head: Douglas Lind
Professors: J. C. Klagge, J. C. Pitt, D. Lind, and L. Patton
Associate Professors: M. Moehler, B. Jantzen, and K. Trogdon
Assistant Professors: K. Kovaka and J. MacKenzie
Visiting Assistant Professors: G. Novack and T. Parent
Adjunct Professor: J. Garrison (School of Education)
Career Advisor: J. C. Pitt (231-5760)
Emeritus: R. Burian, H. B. Miller, and D. Mayo

Web: **https://liberalarts.vt.edu/departments-and-schools/department-of-philosophy.html**

Overview

Courses in philosophy aim at critical understanding and rigorous evaluation of the concepts underlying our views concerning the nature of reality, what sorts of things there are, what can be known, what is of value, and what people ought to do and to aim at. The department offers programs leading to the B.A. and to the M.A. Philosophy majors receive a strong liberal arts education and are prepared for careers that require a broad perspective and independent judgment. They are prepared for graduate work in a variety of scholarly and professional fields. An undergraduate philosophy major is especially appropriate for the student considering law school, medical school, or other professional schools. In addition, philosophy may be chosen as a minor.

Philosophy majors must complete the college core and the Curriculum for Liberal Education or Pathways. Students entering fall 2018 must complete Pathways and successfully complete at least 36 hours in

philosophy, including two courses in the History of Philosophy, Philosophy 3505 (Symbolic Logic), two Core Analytic Philosophy courses, two Value Theory courses, and an additional 15 credit hours of philosophy courses currently offered by the Department of Philosophy. Students must take at least six Philosophy courses at the 3000-4000 level for fulfillment of the "Philosophy Major Requirements". The department has recently added a new Philosophy, Politics, and Economics (PPE) major in Philosophy. See Philosophy Department website for specific details. A double major is possible with any of several other curricula.

Philosophy minors must complete at least 18 hours of philosophy, including one of 1504 or 3505, two courses at the 3000-4000 level, an additional course from either the 3000-4000 level or in the history sequence (2115, 2116, 2125, 2126), and two elective courses in Philosophy (at any level).

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in philosophy.

Satisfactory progress requirements toward the B.A. in philosophy can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (PHIL)

1204: KNOWLEDGE AND REALITY
Examines historical and contemporary approaches to such issues as: the nature of reality and the self, the relationship between mind and body, the existence of God, the nature of knowledge and illusion. Application to ethical questions about the fear of death, and the meaning of life. (3H,3C)

1304: MORALITY AND JUSTICE
A critical survey of theories concerning human nature, the meaningful life, and the moral evaluation of actions, persons, and institutions. Theories will be applied to such issues as abortion, justice, and moral problems faced by professionals. (3H,3C)

1304H: MORALITY AND JUSTICE
A critical survey of theories concerning human nature, the meaningful life, and the moral evaluation of actions, persons, and institutions. Theories will be applied to such issues as abortion, justice, and moral problems faced by professionals. (3H,3C)

1504: LANGUAGE AND LOGIC
Basic concepts in logic and critical thinking: argument, validity, deduction and induction, logical form, formal and informal fallacies. Introduction to the logic of truth functions and of categorical statements. Critical analysis of arguments in ordinary language. (3H,3C)

2115,2116: ANCIENT THROUGH MEDIEVAL PHILOSOPHY
A critical survey and analysis of the history of Western philosophical thought from its beginnings through the Medieval Period. Addresses and assesses historical theories about issues involving the nature of justice, virtue, ethics, knowledge, and reality. Key concepts analyzed include that of the soul, human flourishing, form and matter, the human function and God. 2115: Presocratics, Socrates, Plato, Aristotle, and the Stoics; 2116: late Greek and Roman philosophy, St. Augustine, St. Thomas Aquinas, and William of Ockham. (3H,3C)

2125,2126: HISTORY OF MODERN PHILOSOPHY
Philosophical thought from the seventeenth to the nineteenth century, integrating intercultural analysis and comparisons. 2125: Global traditions in 17th and 18th century natural philosophy, including theories of mind, value, and knowledge. 2126: Global traditions in 18th and 19th century philosophy, including theories of science, knowledge, and value. (3H,3C)

2304: GLOBAL ETHICS
Ethical issues in international context. Application of the principles of moral theory to such issues as the

obligations of richer nations toward poorer ones, cultural and other forms of relativism, emigration and immigration, nationalism, war, deterrence, intervention, environmental degradation, preservation of natural diversity, and responsibilities toward future generations. (3H,3C)

2605,2606: REASON AND REVOLUTION IN SCIENCE
Study of philosophical approaches to understanding and justifying modes of human reasoning both in science and everyday life. 2605: nature of theory confirmation and falsification; 2606: justifying changing paradigms of human inquiry. (3H,3C)

2894 (ECON 2894) (PSCI 2894): INTRODUCTION TO PHILOSOPHY, POLITICS, AND ECONOMICS
Integrated study of philosophy, politics, and economics. Trains students to make decisions that are not only economically sound, but also socially, ethically, and politically informed. Topics include: models of human nature, rational choice theory, social cooperation, distributive justice, markets, and democracy. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3015,3016 (PSCI 3015, 3016): POLITICAL THEORY
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present. Pre: PSCI 2014. (3H,3C)

3024: TOPICS IN PHILOSOPHICAL MOVEMENTS
Focus on the assumptions, methods and ethical dimensions of one or more contemporary or historically important philosophical movement, such as Pragmatism, Feminism, Existentialism, Islamic Philosophy, Philosophy and African-American Thought, or Philosophy and Literature. May be repeated 2 times with different content for a maximum of 9 credits. (3H,3C)

3314: ETHICAL THEORY
Careful examination of some important historical or contemporary ethical theories. Includes coverage of such topics as the assessment of character and action, the foundations of ethical theories, their justification, their relationship to scientific theories, and their objective or subjective status. 3 Philosophy credits required. (3H,3C)

3324: BIOMEDICAL ETHICS
Philosophical analysis of ethical issues in medicine and biotechnology, such as problems arising in connection with the relations between physicians and patients, the challenges of cultural diversity, practices surrounding human and animal research, decisions about end of life care, embryonic stem cell research, genetic engineering, biotechnological human enhancement, and social justice in relation to health-care policy. (3H,3C)

3334: ETHICAL PERSPECTIVES ON ARTIFICIAL INTELLIGENCE
Critical examination of ethical concepts and theories, such as utilitarianism, deontology and virtue theory, applied to issues that arise in artificial intelligence, including applications in smart design & construction, energy, ubiquitous mobility, and robotics & autonomous systems. Addresses questions such as: How much should privacy be protected in the digital future? How can energy be equitably transported and consumed in relation to poor regions and future generations? Who should autonomous vehicles be programmed to protect or sacrifice in emergency situations? How should we evaluate the effects on family and society of smart technology? Should we fear that robots will take over? (3H,3C)

3414: AESTHETICS
Critical survey and analysis of key concepts in aesthetics and the philosophy of art. Historical and contemporary theories concerning natural beauty, aesthetic experience and properties, the nature and interpretation of artworks, their representational and expressive features, the relationship between artistic value, the value that attaches to nature, and moral value. (3H,3C)

3454 (RLCL 3454): PHILOSOPHY OF RELIGION
A consideration of religious belief and its justification with attention to such philosophical issues as the nature and existence of the Judeo-Christian-Muslim God, proofs for the existence of God, the problem of evil, a religious basis for ethics, the nature of faith, and the variety of religious beliefs. (3H,3C)

3505-3506: MODERN LOGIC AND ITS DEVELOPMENT
Logic and logical theory and the history of its development. 3505: Validity of arguments. Syllogistic logic from Aristotle to modern times. Deductive methods in truth functional and quantificational logic through the theory of identity. Translation from English into symbolic form. 3506: Metalogic and the history and philosophy of modern logical theory. Decidability and undecidability, completeness and incompleteness of formal systems. Developments from Cantor to Goedel. Must have 3505 to take 3506. (3H,3C)

4014: SPECIAL TOPICS IN PHILOSOPHY
Critical examination of special issues or figures of current philosophical interest at an advanced level. Sample topics: Philosophy and Race; Ludwig Wittgenstein; Origins of Analytic Philosophy; and Animals, Minds and Morality. May be repeated 2 times with different content for a maximum of 9 credits. Pre: 3 Philosophy credits required. (3H,3C)

4204: PHILOSOPHY OF MIND
Current issues in the philosophy of mind such as relation of mind and body, status of the mental, knowledge of one’s own and other minds, personal identity, consciousness, mentality of animals and machines, topics in the philosophy of psychology. 3 Philosophy credits required. (3H,3C)

4214: METAPHYSICS
Examination of some of the central problems of metaphysics. Topics may include: existence, necessary truth, the problem of universals, causation, the identity of the self through time, free will. Attention will be given both to the historical development of these problems and to contemporary philosophical responses to them. 3 Philosophy credits required. (3H,3C)

4224: EPISTEMOLOGY
Theory of knowledge. Is all knowledge based on experience? Does knowledge have a foundation? Can knowledge of the present and the nearby give us reasons for beliefs about the future, the past, or about events far away? 3 Philosophy credits required. (3H,3C)

4304: POLITICAL PHILOSOPHY
Study of fundamental topics in political philosophy, such as distributive justice, equality, individual rights, constitutional government, and the justification of political authority. 3 Philosophy credits required. (3H,3C)

4324 (MGT 4324): BUSINESS AND PROFESSIONAL ETHICS
An inquiry into the fundamental norms of conduct in business and other professions and their justification in relation to the most important ethical theories. Special attention will be given to moral problems such as the ethics of hiring and firing, bribery, and professional responsibility to society. (3H,3C)

4334: JURISPRUDENCE
An examination of the nature of law and legal systems with attention to traditional theories of law and to such topics as judicial decision and discretion, law and morality, the justification of legal coercion. 3 Philosophy credits required. (3H,3C)

4514: SPECIAL TOPICS IN LOGIC
Topics that build upon a knowledge of classical deductive logic: extensions of classical logic, alternatives to classical logic, philosophy of logic, and philosophy of language. Topics to be announced each semester course is offered. Pre: 3505. (3H,3C)

4604: PHILOSOPHY OF BIOLOGY
This course is designed primarily for students of biology or philosophy students with a strong interest in biology. Topics vary from year to year, but include the changing character of biology as a science, the special character of biological explanations and methods, and the place and value of reduction (e.g., of Mendelian to molecular genetics) in biology. (3H,3C)

4614: PHILOSOPHY OF SCIENCE
An examination of the structure and methodology of science as well as key concepts such as explanation, confirmation, realism, and instrumentalism. One year of science and 3 philosophy credits required. (3H,3C)

4884 (ECON 4884) (PSCI 4884): ADVANCED TOPICS IN PHILOSOPHY, POLITICS, AND ECONOMICS
Advanced topics at the intersection of philosophy, politics, and economics. Core methods and concepts: utility theory, game theory, social choice theory, public choice theory, markets, justice, and democracy. Senior research project. Advanced discourse. Pre: Senior standing. Pre: 2894 or PSCI 2894 or ECON 2894. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

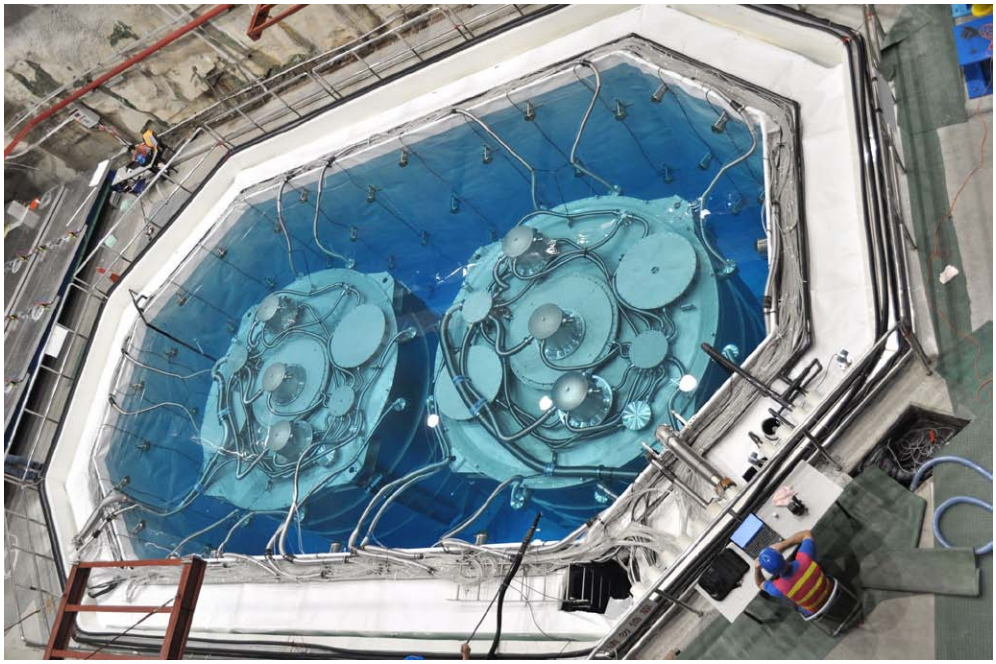
2019-2020 Undergraduate Course Catalog and Academic Policies

Physics

Chair: M. L. Pitt
Professors: N. Arav, L. N. Chang, J.R. Heflin, J. J. Heremans, P. Huber, J. M. Link, D. Minic, P.R. Montague, S.K. Mun, L. E. Piilonen, M. L. Pitt, M. J. F. Pleimling, E.R. Sharpe, J. H. Simonetti, U. Tauber, and R. B. Vogelaar
Associate Professors: S. Economou, G. Khodaparast, C. Mariani, K. Park, H. Robinson, V. W. Scarola, V. Soghomonian, and T. Takeuchi
Assistant Professors: L. Anderson, R. Ashkar, E. Barnes, S. Cheng, S. Emori, D. Farrah, J. Gray, S. Horiuchi, V. Nguyen, T. O'Donnell and C. Tao
Assistant Collegiate Professors: B. Magill and T. R. Merritt
Instructors: A. Khan, K. Papavasiliou, and A. L. C. Robinson
Research Faculty: I. Ozcan and K. Wong
Adjunct Professors: C. D. Bowman, Z. Chang, D. Edmonds, R. Li, M. Freedman, Y. Liang, G. R. Myneni, and Z. Toroczkai
Affiliated Faculty: L. Asryan[1], S. Eubank[2], L. Guido[3], J. Hanna[4], S. Jung[4], A. Onufriev[6] and M. Paul[7]
William E. Hassinger, Jr., Senior Faculty Fellow in Physics: R. B. Vogelaar

[1]Regular appointment with Material Science and Engineering
[2]Regular appointment with the Virginia Bioinformatics Institute
[3]Regular appointment with Materials Science & Engineering and Electrical & Computer Engineering
[4]Regular appointment with Biomedical Engineering and Mechanics
[6]Regular appointment with Computer Science
[7]Regular appointment with Mechanical Engineering

Web: **www.phys.vt.edu**



Overview

The physics curriculum is designed to provide a broad foundation in the physical sciences, as well as specialized training in classical and modern physics, and it may lead to either a B.S. or a B.A. An honors student may also qualify for a five-year program leading to both the B.S. and M.S. Experimental opportunities are available in such fields as fundamental particle physics, nuclear physics, condensed matter physics, laser optics, and astronomy. Students are encouraged to participate with faculty members in undergraduate research projects.

Liberal emphases in the physics curriculum permit students to give special attention to those aspects of the discipline they prefer and enable them either to pursue a traditional course of study as preparation for joining the technical staffs of industries or government laboratories, or for graduate studies in physics or astronomy (B.S.); or to pursue an interdisciplinary course of study with a strong background in physics (B.A.).

A handbook that includes sample curricula for emphases in astrophysics, biophysics, chemistry, computer science, education, electrical engineering, finance, geophysics, materials science, mathematics, physics education, pre-health, and pre-law is available from the department on request.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Majors

- Physics B.S. (Outstanding students may also elect to complete the requirements for a B.S. "in honors". A description of this honors program in physics is included in the handbook indicated above.)
- Physics B.A.
- Physics B.A. Physics Education Option
- Physics B.A. Pre-Health Option
- Physics B.A. Pre-Law Option

The department also offers the M.S. and Ph.D. in physics (see the Graduate Catalog).

Transfer students should contact the department early, preferably one full semester prior to entrance. This procedure will allow a thorough evaluation of transfer credits and correct placement.

The department participates in the Cooperative Education Program in which a student may alternate through two successive years a semester of study with a semester of professional employment in his/her discipline; these two years normally replace the student's sophomore year. Additional information on the program is included in the "**Academics**" section in this catalog and in the handbook indicated above.

Minors

A student may obtain a minor in physics or astronomy or biophysics, by registering with the department and successfully completing the approved minor requirements in effect at the time of graduation. Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for minor requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.S. and B.A. in Physics can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (PHYS)

1055,1056: INTRODUCTION TO ASTRONOMY
Survey course of astronomy topics ranging from the solar system to the universe, with Application of evidence-based reasoning, critical thinking, and use of theoretical models and observations. 1055 has a focus on the solar system: apparent sky motions, telescopes, matter and radiation, properties of the planets, structure and evolution of the solar system, cultural and intercultural aspects that influenced the understanding of the solar system, climate change as a Global challenge. 1056 has a focus on the universe: stars, star formation, stellar evolution, organization of the Milky Way Galaxy, galaxies, quasars, structure and evolution of the universe, cosmological models, cultural and intercultural aspects of the development of astronomical thought, life in the universe. (3H,3C)

1155,1156: ASTRONOMY LABORATORY
Simulation of apparent sky motions; observations of planets, stars, and nebulae with quantitative analysis; long term observations of sky changes; analysis of images; laboratory experiments of astrophysical relevance. Co: 1055 for 1155; 1056 for 1156. (3L,1C)

2074: HIGHLIGHTS OF CONTEMPORARY PHYSICS

Conceptual overview of modern scientific thinking in physics, with application of critical reasoning and quantitative and conceptual problem solving based on fundamental physics principles. Presentation of the key ideas and philosophical aspects of the most important developments in modern physics, such as quantum mechanics, relativity, particle physics, cosmology. Discussion of their impact on our understanding of the universe, our position in it, intercultural aspects, and the relevance of physics for technical challenges requiring global awareness. (3H,3C)

2114: BLACK HOLES
Properties of black holes and the astronomical evidence for their existence. Black holes as the most simple objects in the Universe. Algebra-based physical nature of black holes, space, time and gravity through Newton's and Einstein's theories. Predicted types and properties of black holes, the deaths of starts, detecting black holes, black holes in the centers of galaxies, and singularities. (3H,3C)

2205-2206: GENERAL PHYSICS
General physics course sequence for students in curricula other than physical sciences, mathematics, or engineering, who have not studied calculus. Applications of reasoning in the natural sciences using physical laws in a real-world context and in the student's own discipline. Overview of intercultural and universal aspects of physics, and of human benefits of physics to address global challenges. 2205: mechanics, wave phenomena, fluids. 2206: optics, thermodynamics, electromagnetism, relativity, topics in nuclear and modern physics. Pre: MATH 1016 or MATH 1016H or MATH 1025 or MATH 2015 or MATH 1026 or MATH 1205 or M ATH 1205H or MATH 1525 or MATH 1535 or MATH 1225 or MATH 1225H for 2205; 2305 or 2205 for 2206. (3H,3C)

2215-2216: GENERAL PHYSICS LABORATORY
Laboratory experiments dealing with basic laws and techniques of physics; designed to illustrate topics covered in PHYS 2205-2206. Applications of reasoning in the natural sciences using physics experiments in a real-world and interdisciplinary context. Ethical responsibilities and issues in a laboratory setting. 2215: analysis of experimental errors, formatting for presenting graphical data, analyzing and describing and prioritizing experimental design features, communicating concepts orally and in writing, concepts of force, momentum, conservation of energy, wave and interference phenomena. 2216: analysis of experimental errors, communicating concepts orally and in writing, concepts of geometrical optics, optical instruments, heat and phase transitions, electricity and electrical energy storage, magnetic fields and magnetic induction, atomic spectra. Co: 2205 for 2215; 2206 for 2216. (3L,1C)

2305-2306: FOUNDATIONS OF PHYSICS
Introductory sequence for students in physical sciences, mathematics, and engineering. Overview of intercultural contributions to physics and universal aspects of physics, and of human benefits of physics to address world-wide challenges. 2305: classical mechanics of translational and rotational motion, Newtonian gravitation, and thermal physics. 2306: oscillations, waves, electricity, magnetism, and optics. Co: 2325 or (MATH 1206 or MATH 1206H or MATH 1226) for 2305. Pre: (MATH 1205 or MATH 1205H or MATH 1225) or (MATH 1206 or MATH 1206H or MATH 1226) for 2305; (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305 for 2306. (3H,3L,4C)

2324: THERMAL PHYSICS MODULE
Introduction to thermal physics; solids, liquids, and gases; moles, temperature, ideal gas law; work, heat, first law of thermodynamics, ideal gas processes; molecular speeds, pressure; heat engines, refrigerators, the second law of thermodynamics. Intended for transfer students whose introductory physics courses did not include thermal physics. (1H,1C)

2325-2326: SEMINAR FOR PHYSICS MAJORS
Introduction to the field of physics and to the Physics Department. Overview of modern physics topics such as special relativity, quantum mechanics, condensed matter, nuclear, and particle physics. Presentation of research activities in the department. Also provides more in-depth discussion of and math preparation for topics in 2305-2306. For physics majors. Co: 2305 for 2325; 2306 for 2326. (1H,1C)

2334: WAVES AND SOUND MODULE
Introduction to mechanical waves and sound; one-dimensional waves, transverse waves, sinusoidal waves; sound waves; waves in two- and three-dimensions; power, intensity; the Doppler Effect; principle

of superposition of waves; standing waves, standing waves on a string, standing sound waves; interference of waves, interference in two and three-dimensions. Intended for transfer students whose introductory physics courses did not include the topics of mechanical waves and sound. Pre: 2305. (1H,1C)

2344: OPTICS MODULE
Introduction to ray and wave optics; the ray model for light; reflection and refraction; image formation by mirrors; image formation by lenses; lenses in combinations, optical instruments; the wave model of light; interference of light waves; diffraction of light waves. Intended for transfer students whose introductory physics courses did not include introductory optics. Co: 2334. (1H,1C)

2404: PHYSICS OUTREACH
Service learning through teaching. An early field experience for physics students who are interested in physics education. Visit local schools and host campus visits to teach K-12 students fundamental physics concepts by performing physics demonstrations and activities. Learn successful communication techniques, lead classroom discussions, and utilize pedagogical content knowledge to effectively organize physics presentations to the general public. Repeatable (no maximum). Variable credit course. Co: 2305.

2504: MATH METHODS IN PHYSICS
Applications of mathematical methods to physics. Topics include spatial coordinate systems, linear algebra techniques in coupled motions, series approximations of solutions to physical systems, extremum problems in physics, differential equations in mechanics, integration in two and three spatial dimensions, probability theory in thermal physics. Co: 2306, (MATH 2214 or 2214H) and (MATH 2224 or 2204 or 2204H). Pre: 2305. Co: MATH 2214, MATH 2224, 2306. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

2994H: UNDERGRADUATE RESEARCH
Honors Variable credit course.

3154: OBSERVATIONAL ASTROPHYSICS
Telescopic observations of the moon, planets, stars, interstellar medium, and galaxies; astrophotography; digital imaging. Telescopes; virtual observing techniques and instruments; photographic and digital imaging systems. Astronomical data reduction and interpretation; digital image processing. Prior credit for PHYS 2154 precludes credit for 3154. Pre: 1156. (1H,3L,2C)

3254: ENRICHED PHYSICS OUTREACH
Design and implementation of physics lesson plans for K-12 students at local schools and campus visits. Creation of inquiry-based, student-centered physics lessons which motivate and educate students of all ages. Development of activities and experiments to engage students in being scientists. Co: 2306. (3H,3C)

3314: INTERMEDIATE LABORATORY
Characteristics of common instrumentation and basic circuits, methods of producing good practices in data gathering, recording, and analysis. (2H,3L,3C)

3324: MODERN PHYSICS
Photons and their interactions with matter, wave-particle duality, Heisenberg uncertainty principle, Schrodinger's equation of motion, hydrogenic and multi-electron atoms, Pauli exclusion principle, molecules, solids, nuclei, elementary particles. Includes lab work. MATH 4544 can be substituted for co-requisite MATH 2214 or 2214H. Co: 2504, MATH 2214 or MATH 2214H. Pre: 2306. Co: MATH 2214, 2504. (3H,3L,4C)

3355-3356: INTERMEDIATE MECHANICS
Formal aspects of classical mechanics and dynamics. Topics include Newtonian, Lagrangian and Hamiltonian theory applied to non-relativistic systems in one, two, and three dimensions, relativistic dynamics, linear algebra applied to coupled many-body motion, small oscillations, and rigid body motion. Pre: (MATH 1224 or MATH 2204 or MATH 2204H), (MATH 2214 or MATH 2214H), PHYS 2305, PHYS 2306, PHYS 2504 for 3355; 3355 for 3356. (3H,3C)

3405-3406: INTERMEDIATE ELECTRICITY AND MAGNETISM
Electrostatics, multipoles, Laplace's equation, and dielectric media. Magnetostatics, magnetic media, and electromagnetic induction. Maxwell's equations, electromagnetic energy, waves, and radiation. Must meet pre-requisites and have a grade of C or better in each of 2305-2306 sequence. Pre: (MATH 2214 or MATH 2214H), PHYS 2305, PHYS 2306, PHYS 2504 for 3405; 3405 for 3406. (3H,3C)

3655,3656: INTRODUCTION TO ASTROPHYSICS
Application of elementary physical laws to determine dimensions, masses, luminosities, structures, and evolution of astronomical objects and the universe as a whole. Emphasis is on quantitative derivation. Pre: 2306. (3H,3C)

3704: THERMAL PHYSICS
Introduction to the concepts, formalism, and applications of classical and quantum statistical mechanics, including thermodynamics. Co: 2504, (MATH 2214 or 2214H). Pre: 2306, 3324. Co: MATH 2214, 2504. (3H,3C)

4224: PHYSICS TEACHING AND LEARNING
Seminar course on how people learn and understand key concepts in physics to encourage more effective teaching strategies. Discussions of readings in physics, physics education research, and cognitive science. Recognition of common student preconceptions of physics concepts and identification of strategies which help to elicit conceptual change. Field work teaching precollege or college students. For students interested in teaching and learning physics, graduate teaching assistants, and undergraduate learning assistants. Pre: 2306. (2H,2C)

4254: QUANTUM INFORMATION TECHNOLOGIES
Quantum computing and other quantum information technologies. Differences between bit and qubit. Quantum logic gates, concept of entanglement, quantum teleportation, quantum cryptography and key distribution, quantum computing algorithms, including Deutsch-Jozsa algorithm, Grover's search algorithm, Shor's factoring algorithm. Basics of public-key cryptosystems and number theory as needed to present Shor's algorithm. Errors in a quantum computer and quantum error correction. Pre: 2306, (MATH 2114 or MATH 2114H). (3H,3C)

4315-4316: MODERN EXPERIMENTAL PHYSICS
Representative apparatus, techniques, and phenomena of contemporary research. Includes electrical measurements, computers, thermometry, vacuum deposition, machine shop, nuclear spectra, experimentation related to major developments of modern physics. Pre: 3314 for 4315; 3314, 4315 for 4316. (6L,2C)

4455-4456: INTRODUCTION TO QUANTUM MECHANICS
Experimental bases; postulates; conservation theorems and symmetry; one-dimensional and two-dimensional problems; angular momentum and problems in three dimensions; matrix mechanics and spin; applications to atomic and molecular physics; perturbation theory; scattering. Pre: 3356 for 4455; 4455 for 4456. Co: 3406 for 4455. (3H,3C)

4504: INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS
Structure and properties of atomic nuclei and elementary particles, theoretical interpretations based on elementary quantum mechanics. Symmetries; various nuclear models; interactions at small distances; classification of elementary particles. Consent required. Co: 4456. (3H,3C)

4554: INTRODUCTION TO SOLID STATE PHYSICS
Basic concepts of solid state physics including crystal structure, lattice vibrations, electron states, energy bands, semiconductors, metals. Consent required. Co: 4456. (3H,3C)

4564: POLYMER PHYSICS
Introduction to the field of polymer physics. Statistical descriptions of polymers based on Brownian motion and random walk models. Conformations and single chains. Thermodynamics of polymer mixtures, solutions, and melts. Properties of polymer networks. Polymer dynamics in both melt and solution states. Pre: 2306. (3H,3C)

4574: NANOTECHNOLOGY
Introduction to methods of controlling matter on the nanometer length scale and the applications thereof. Nanolithography, self-assembly, and scanned probe microscopy; nanomaterials including fullerenes, carbon nanotubes, and quantum dots; nanoscale and molecular electronics; nanoelectromechanical systems; nanoscale optoelectronics; and nanobiotechnology. Pre: 2205, 2206 or 2305, 2306. (3H,3C)

4614: OPTICS
Fundamentals of the ray, wave and quantum models of light, and topics in modern optics with contemporary applications. Pre: 2306, MATH 2214, (MATH 2224 or MATH 2204 or MATH 2204H). (3H,3C)

4624: OPTICS LABORATORY
Laboratory experiments dealing with ray and wave optical phenomena designed to illustrate and complement the principles covered in OPTICS PHYS 4614. Physics majors are required to take 4624 concurrently with the lecture course 4614. Co: 4614. (3L,1C)

4654: MODERN COSMOLOGY
Survey of our current understanding of the origin, evolution, and fate of the Universe. Observational evidence behind the idea of the hot Big Bang, including the linear velocity-distance law, the existence of the cosmic microwave background, and the arguments for dark matter. Physics of a dynamic, expanding Universe via the Friedman-Lemaitre- Robertson-Walker metric. Physical principles to determine the conditions in the early Universe, introducing the idea of inflation. Mechanisms driving the origin and evolution of galaxies and large-scale structures. Pre: 3656. (3H,3C)

4674: INTRODUCTION TO GENERAL RELATIVITY
Introduction to methods and applications of Einstein's general theory of relativity. Space and time and gravity in Newtonian physics; special theory of relativity, gravity as geometry of curved space-time; black holes; cosmology; Einstein's gravitational field equations; gravitational waves and relativistic stars. Pre: MATH 2214 or MATH 2214H or MATH 2514, PHYS 3356. Co: 3406. (3H,3C)

4714: INTRODUCTION TO BIOPHYSICS
Selected topics from the general area of biomechanics, bioelectricity, radiation biophysics, molecular biophysics, and thermodynamics and transport in biological systems. Emphasis on the physical aspects of biological phenomena and biophysical measurement techniques and instrumentation. Pre: 2206 or 2306 or ISC 2106H. (3H,3C)

4755-4756: INTRODUCTION TO COMPUTATIONAL PHYSICS
Survey of computational methods in physics. 4755: Applications in physics of curve fitting, numerical calculus, ordinary and partial differential equations, numerical methods for matrices, spectral analysis, and N-body systems. 4756: Investigation of physical systems using Molecular Dynamics simulations, Monte Carlo simulations, genetic algorithm and numerical renormalization. Introduction to advanced techniques, as for example density matrix renormalization group method, matrix product state approach, smoothed particle hydrodynamics, and density functional theory. Pre: 2306, CS 1044 or CS 1054 or CS

1064 or CS 1114 or ECE 1574 or AOE 2074 or ESM 2074 for 4755; 4455, 4755 for 4756. (3H,3C)

4774: INTRO TO PHYSICS OF GALAXIES
Survey of our current observational and theoretical understanding of the formation and evolution of galaxies. Observational review of galaxy sizes and compositions, including the origin of the Hubble sequence. Physical description of a galaxy via distribution functions and stellar orbits. Time evolution of the distribution function. The Schwarzschild method for determining orbits. The physics of active galaxies. Pre: 3656. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Plant Pathology, Physiology, and Weed Science

Head: Boris A. Vinatzer
Professors: J. F. Derr, J. D. Eisenback, E. A. Grabau, R. Grene, C. Hong, C. S. Johnson, D.B. Langston Jr., J. M. McDowell, D. G. Schmale III, B. A. Vinatzer, J. H. Westwood, and K. S. Yoder
Associate Professors: S. D. Askew, M. Balota, J. N. Barney, A. B. Baudoin, E. Colláková, J. G. Jelesko, G. Pilot, and S. L. Rideout
Assistant Professors: M. L. Flessner, D. C. Haak, D. S. McCall, H. L. Mehl, M. Nita, and X. Wang
Special Research Faculty: E. A. Bush, D. S. McCall, and S. Y. Park
Instructor: M. A. Hansen

Web: **www.ppws.vt.edu**

Overview

The primary mission of the department is research, extension and graduate education in the areas of plant pathology (nature, biology and control of plant diseases), plant physiology, and weed science (weed biology and control, action of herbicides). No undergraduate majors are offered in these areas, but the department does offer an undergraduate minor in Plant Health Sciences, focused on managing plant health in response to a variety of biotic and abiotic threats. These threats include pathogens, weeds, insects and environmental stressors (drought, heat, cold, pollutants, nutrients) that impact our food crops, forests, and landscape plants; students in the Departments of Crop and Soil Environmental Sciences, Horticulture, Biological Sciences, or Biochemistry are most likely to enroll in this minor, but students in other departments may participate as well if they have the prerequisite freshman biology and chemistry courses. Consult the department office (413 Price) or web site (**www.ppws.vt.edu**) for more information

on the minor. Several undergraduate courses offered by the department are also required or electives for students in agricultural or biological majors. These courses are designed to furnish basic knowledge of the nature, diagnosis, and control of plant diseases; identification, biology, and control of weeds; plant metabolism, nutrition, molecular biology, and growth regulation; invasive plant biology; and modern pest management and pesticide usage.

The department offers graduate programs leading to M.S. in the life sciences and Ph.D. in plant pathology, plant physiology and weed science. A non-thesis M.S. program in plant protection and pest management is also available (see **Graduate Catalog**).

Undergraduate Course Descriptions (PPWS)

2004: MYSTERIOUS MUSHROOMS, MALICIOUS MOLDS
Study of the fungi and their close relatives, with special attention to their roles in the natural world and in shaping the course of human history. Historical and practical significance of fungi as sources of medicine, pathogens of plants and animals, rotters and decayers of organic matter, makers of food and drink, manufacturers of dangerous toxins, and producers of mind-altering chemicals. A student must have a basic understanding of biology. (3H,3C)

2104: PLANTS, GENES, AND PEOPLE
Explores how and why humans have manipulated plant genomes from prehistory through the current genomic era by examining the scientific, cultural, historical, and legal aspects of plant gene management in both conventional and transgenic crops. Pre: BIOL 1005 or BIOL 1105. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3504: PLANT PHYSIOLOGY AND THE BIOTIC ENVIRONMENT
Course explores how both agricultural and non-crop plants grow, develop, and respond to biotic environmental influences. Topics include symbiotic and pathogenic microorganisms, herbivores, phytoremediation, parasitic plants, and weeds. The scope ranges from biochemical, cellular, tissue, to whole plant physiology. Course includes an experimental project in plant physiology on one of the topics. Pre: (BIOL 1006 or BIOL 2304), CHEM 1036. (3H,3C)

3514: PLANT PHYSIOLOGY LAB
A laboratory course designed to illustrate basic physiological principles related to nutrient deficiencies, membrane permeability and composition, water/nutrient absorption and translocation, transpiration, photosynthesis, physiological functions of growth regulators, enzyme activity, and elemental composition of plant tissue. Course requirements may be satisfied by taking PPWS 3504 or CSES 4344 prior to or concurrent with this course. (3L,1C)

3754: WEEDS THAT SHAPE OUR WORLD
Introduction to weed management methods, weed characteristics- chemistry, morphology and reproduction, and the economic and social factors that both drive and limit efforts to control plant populations. Identification of weed species. Pre: (BIOL 1005 or BIOL 1105 or BIOL 1205H), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

4104: PLANT PATHOLOGY
Introduction to plant pathology as a science and a crop protection discipline. Plant disease diagnosis, biology, and identification of plant disease-causing agents, factors leading to disease build-up, and management of plant diseases. Diseases of specific crops are studied as examples to illustrate general principles. Pre: (BIOL 1005 or BIOL 1105), (BIOL 1006 or BIOL 1106). (3H,3L,4C)

4114: MICROBIAL FORENSICS AND BIOSECURITY
Concepts of comparative and evolutionary genomics for pathogen characterization and identification taught through case studies of bioterrorism, involuntary and voluntary disease transmission, infectious disease epidemics, and genetically modified organisms; emphasis placed on unambiguous source attribution of a disease outbreak to a particular microbe, risk assessment, response as individual, community, and nation to a bioterrorism attack or disease outbreak, federal biosecurity regulations, and career opportunities. Pre: BIOL 2604, (BIOL 2104 or BIOL 2004). (3H,3C)

4154: PLANT PROBLEM DIAGNOSIS
Plant problem diagnosis in the laboratory and field, including recognition of disease, insect and abiotic (nonliving) problems, as well as the major groups of plant pathogens of a variety of regionally important horticultural and agronomic crops. General management options for pests and pathogens. Co: 4104. (2H,3L,3C)

4264 (ENT 4264): PESTICIDE USAGE
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides. Pre: CHEM 2515 or CHEM 2536. (2H,3L,3C)

4504: FUNDAMENTALS OF PLANT PHYSIOLOGY
Fundamental principles of plant physiology (photosynthesis, respiration, transpiration, nutrition, translocation, and development) will be integrated with discussion of the relationship between abiotic environmental factors and plant physiological processes. Both agricultural and non-crop plants will be emphasized. Pre: (BIOL 1006 or BIOL 2304), CHEM 1036. (3H,3C)

4604: BIOLOGICAL INVASIONS
Broad overview of the causes, consequences, and epidemiology of invasive plants, animals, and microbes. Conceptual, mechanistic, societal, and political components of invasive species from Darwin to modern day, covering the invasion process from introduction to ecological or economic impact. Taxonomy, management, and risk assessment will be covered via case studies, within a policy context. Pre: BIOL 1105, BIOL 1106. (2H,3L,3C)

4754: WEED SCIENCE: PRINCIPLES AND PRACTICES
Weeds and human affairs; costs and losses; emphasis on weed biology, weed identification and weed-crop ecology; agronomic, physiological, and chemical principles underlying prevention, eradication, and control of undesired vegetation; methods of weed control available for modern agronomic, forestry, horticultural, and non-crop situations. Pre: BIOL 2304, CHEM 1036. (2H,3L,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Political Science

Chair: Timothy W. Luke
University Distinguished Professor: T. W. Luke
Edward S. Diggs Professor in the Social Sciences: E. Weisband
Professors: F. Debrix, K. M. Hult, I. A. Luciak, and L. Zanotti
Associate Professors: C. Apodaca, P. Dixit, B. Koch, D. J. Milly, W. D. Moore, S. G. Nelson, A. J. Scerri, and I. Stivachtis
Assistant Professors: P. C. Avey, B. S. Biney, A. F. Brantley, M. Caraccioli, C. Daggett, B. Gill, N. Goedert, K. E. Kitchens, E. Jardine, C. Jewitt, D. Poets, B. Pula, and A. Reeves
Collegiate Assistant Professors: B. S. Faulkner and C. I. P. Thomas
Instructors: J. A. Hanratty
Emeritus Faculty: R.C. Rich, R.D. Shingles, C.L. Taylor, and C.E. Walcott
Internship Director: C. I. P. Thomas (231-2855)

Web: **www.psci.vt.edu**

Overview

The department offers courses leading to degrees in Political Science and International Studies. These courses provide understanding of political systems, forms of government, international relations and other political processes throughout the world. Political science courses also offer preparation for careers in government, business, nonprofit/nongovernemnt organizations, law, politics, and education.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

General Option for the B.A. Degree

The general option encourages students to take courses in all of the subfields of political science, including political theory, comparative politics and government, U.S. politics and government, international relations, and research methodologies and methods. This permits students to describe, analyze, and evaluate governments, public policies, and political processes, systems, and behaviors, locally, nationally and globally. Students choosing this option pursue careers in government, nongovernmental organizations, business, education, law, policy analysis, and politics.

Legal Studies Option for the B.A. Degree

The Legal Studies option allows students to explore values, ideas, and reasoning linked to public law, its design, and its impact, preparing them for law school, graduate work in public policy fields, and a range of endeavors in and outside of governments. The option is not intended to be a pre-law program, although students hoping to attend law school may enroll for the option and may well benefit from its achievement.

National Security Option for the B.A. Degree

This option is intended to help students understand policy making in relation to the national security of the United States. Students are directed toward courses in foreign and military policy and the presidential and congressional branches of U.S. government.

Political Thought Option for the B. A. Degree

This option directs attention to courses in the department that focus upon political thought and to courses in other university departments that deal with ethical thought. This cross-disciplinary approach is designed to enable students to contextualize their study of political theory and ethics in a broad scholarly framework.

Minors

The requirements to earn a minor in Political Science or in National Security and Foreign Affairs can be found on the specific checksheets available on the University Registrar's website.

Students majoring or minoring in Political Science or in International Studies may not complete the National Security and Foreign Affairs minor.

Regarding Double Majors

The Department of Political Science offers majors in both Political Science and International Studies. Courses for the majors overlap significantly. Therefore, students may not pursue a major in Political Science and a major in International Studies simultaneously, nor major in one and minor in the other.

Advising

The department provides advisors to help students understand and meet degree requirements. Career counseling also is available in the department, as is advising for students interested in attending graduate or law school after graduation from Virginia Tech.

Internships

The department arranges academic credit for internships in state, local, and federal governments, nonprofit organizations, and other appropriate settings. The department's internship program offers students a chance to gain career-related experience in a wide variety of organizations. Information on these opportunities can be obtained from the internship director.

Student Organizations

To provide opportunities for informal association of faculty and students, the department sponsors the Political Science Club; a chapter of Phi Alpha Delta, the pre-law honor society; a chapter of Pi Sigma Alpha, the national honor society in political science; and other student organizations such as Model United Nations. Information about these activities, as well as about any other aspect of the department, may be obtained from the department chair, advisors, or the department office.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Curriculum for Liberal Education (see Academics chapter in this catalog), toward the department's general education requirements, and toward the degree in Political Science.

Satisfactory progress toward the B.A. in political science requires completion of PSCI 1014, 1024, and 2024 within the first 60 credit hours attempted. Students must also maintain an in-major GPA of 2.0 and must achieve a minimum grade of C in both PSCI 1014 and 1024.

Study Abroad

Virginia Tech offers a variety of study abroad programs.

Honors

Departmental Honors Courses are occasionally offered by the Political Science Department. Political Science majors are encouraged to apply for the Honors College if they meet Honors College application

eligibility requirements. Visit **www.honorscollege.vt.edu** for more information.

Undergraduate Course Descriptions (PSCI)

1004 (IS 1004): NATIONS AND NATIONALITIES
Introduction to world and American ethnic and indigenous cultures and to social constructions of human and group identity, nationalism and extreme ethno-nationalism. History of the political, economic, and cultural transition from primordial communities to sovereign states. Introduction to the rise of racism, sexism, ethnicism, classism, nativism, xenophobia, etc. in modern societies and episodes of mass political violence including ethnic cleansing and genocide. (3H,3C)

1014: INTRODUCTION TO UNITED STATES GOVERNMENT AND POLITICS
Introduction to government and politics of the United States, the Constitution, and various institutional designs and structures. Focus on political culture, interest groups, voting franchise, political parties, and elections. Roles and responsibilities of Congress, bureaucracy, Presidency, and federal courts; Discussion of selected current policy issues and implications of diversity of elected representatives. (3H,3C)

1014H: HONORS INTRODUCTION TO UNITED STATES GOVERNMENT AND POLITICS
Introduction to government and politics of the United States, the Constitution, and various institutional designs and structures. Focus on political culture, interest groups, voting franchise, political parties, and elections. Roles and responsibilities of Congress, bureaucracy, Presidency, and federal courts; Discussion of selected current policy issues and implications of diversity of elected representatives. (3H,3C)

1024 (IS 1024): INTRODUCTION TO COMPARATIVE GOVERNMENT AND POLITICS
Government and politics of selected countries in the world: the necessity for government; the nature of politics and governmental systems; specific types of political systems; the effects and consequences of institutional designs; linkages of people and governments through political parties, interest groups, and social movements; current political issues. (3H,3C)

1024H: HONORS INTRODUCTION TO COMPARATIVE GOVERNMENT AND POLITICS
(3H,3C)

1034 (IS 1034): INTRODUCTION TO INTERNATIONAL STUDIES AND POLITICAL SCIENCE
Introduces students to the fields of International Studies and Political Science and their respective subfields. Familiarizes students with the undergraduate programs in International Studies and Political Science and emphasizes student preparation for careers in the respective fields. Focuses on inquiry, problem-solving, and integration of ideas and experiences with a focus on International Studies and Political Science. Familiarizes students with the basic principles of the research and writing principles. (3H,3C)

1XXX3: GEN ED REASONING SOCIAL SCI
(3H,3C)

2014: INTRODUCTION TO POLITICAL THEORY
Examines central themes involved in the practices of normative political theory. Topics will include critical review of the historical origins, established traditions, and major themes in normative political thinking. (3H,3C)

2024: RESEARCH METHODS IN POLITICAL SCIENCE
Introduction to research in political science; formulation of theory, operationalization and measurement, gathering, analysis and interpretation of data. Pre: 1014 or 1014H, 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

2034 (GEOG 2034) (IS 2034): GEOGRAPHY OF GLOBAL CONFLICT
Geographical dimensions of global conflicts, international 'management' of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts,

current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes. (3H,3C)

2044 (FST 2044) (IS 2044): FOOD, WAR AND CONFLICT
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict. (3H,3C)

2054 (GEOG 2054) (IS 2054): INTRODUCTION TO WORLD POLITICS
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues. (3H,3C)

2064 (GEOG 2064) (IS 2064): THE GLOBAL ECONOMY AND WORLD POLITICS
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies. (3H,3C)

2074: LAW AND POLITICS
Explores the roles of law and legal institutions within the United States. Focuses on structures and procedures of government from a constitutional perspective; the politics of law-making and law-enforcement by legislative, executive, and judicial institutions; and relationships between law and society. Pre: 1014 or 1014H. (3H,3C)

2084 (IS 2084): THEORETICAL APPROACHES TO GLOBAL ORDER
Examines the evolution of the inter-state system and focuses on the political, economic, societal and technological processes that shape the relations among states and people. Investigates topics such as the role of religion, culture and civilizations in world affairs; the globalization of the European system and the question of human equality; the impact of colonialism and post- colonialism on the question of justice and rights; and the effects of imperialism, capitalism and globalization on world order. (3H,3C)

2134 (GEOG 2134) (IS 2134): GEOG OF THE GLOBAL ECONOMY
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century. (3H,3C)

2164 (BIT 2164) (CS 2164): FOUNDATIONS OF CONTEMPORARY SECURITY ENVIRONMENTS
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats. (3H,3C)

2894 (ECON 2894) (PHIL 2894): INTRODUCTION PHILOSOPHY, POLITICS, AND ECONOMICS
Integrated study of philosophy, politics, and economics. Trains students to make decisions that are not only economically sound, but also socially, ethically, and politically informed. Topics included: models of human nature, rational choice theory, social cooperation, distributive justice, markets, and democracy. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

29843: SPECIAL STUDY
Variable credit course.

3004 (IS 3004): PROFESSIONALISM AND CAREERS IN POLITICAL SCIENCE AND INTERNATIONAL STUDIES
Designed to teach students how to synthesize skills and information learned in their Political Science and International Studies classes. Exploration of various career options, graduate school options, and proper procedures for seeking and applying for employment and graduate school. Introduction to professionalism in the workplace and professional development in the area of political science and international studies. Junior Standing. (3H,3C)

3015,3016 (PHIL 3015, 3016): POLITICAL THEORY
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present. (3H,3C)

3034 (GEOG 3034) (IS 3034): THE CIA: ITS CAPABILITIES IN TODAY'S GEO-POLITICAL WORLD
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIA's operations in different regions of the world. (3H,3C)

3044 (IS 3044): THE POLITICS OF INTERNET GOVERNANCE
Introduces students to theoretical, technological, and policy debates in Internet governance. Topics include multistakeholder governance, cybersecurity and cybercrime, network investigative techniques, data protection, vulnerability disclosure, use of anonymity-granting technologies, network neutrality, virtual currencies, big data, algorithmic bias and decision-making, politics of the domain name system, privacy, free expression, cross-border dispute resolution, data ownership, and challenges to state authority. Pre: 2054 or IS 2054 or GEOG 2054. (3H,3C)

3054 (IS 3054): THE DARK WEB AND THREAT ANALYTICS
Introduction to dual-use anonymity-granting technologies such as the Dark Web. Covers open source threat intelligence as a technique to assess trends and trajectories in anonymous online content. Substantive topics include the use of Dark Web technologies for political expression in repressive regimes, anonymity and privacy protection in an age of big data as well as the misuse of these tools for doxing, trolling, and the creation of illegal markets for drugs, guns, malicious software, human trafficking, and child abuse imagery. Junior Standing (3H,3C)

3104 (IS 3104): SECURITY STUDIES: THEORIES AND CONCEPTS
Introduces the various theoretical approaches to security. Examines key concepts in the field of Security Studies, such as uncertainty, polarity, war, coercion, terrorism, intelligence, genocide, crimes against humanity, ethnic conflict, and human security. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3114 (IS 3114): GLOBAL SECURITY
Explores various theoretical approaches to security and discusses traditional and non-traditional security issues. Focuses on global, international and regional security challenges and examines alternative strategic and tactical solutions for addressing them. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3115,3116 (IS 3115, 3116): SELECTED WORLD PROBLEMS
Selected world problems and how they affect various countries. Each semester, a topic will be chosen. (3H,3C)

3125-3126 (IS 3125-3126): INTELLIGENCE AND NATIONAL SECURITY
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process. Pre: IS 2054 or PSCI 2054 or GEOG 2054 for 3125; IS 3125 or PSCI 3125 for 3126. (3H,3C)

3134 (IS 3134): GLOBAL CONFLICT AND WAR
Focuses on the causes, legal and moral constraints, impacts, and consequences of conflict and war. Explores historical and contemporary cases of conflict and war and investigates the role of state and non-state actors in these conflicts. Examines the impact of technology, religion, culture and identity on the present and future of war. (3H,3C)

3135-3136 (IS 3135-3136): STRATEGIES FOR MODERN WARFARE
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism. Pre: IS 2054 or PSCI 2054 or GEOG 2054 for 3135; IS 3135 or PSCI 3135 for 3136. (3H,3C)

3144 (IS 3144): GLOBAL GOVERNANCE & PUBLIC POLICY
Examines the norms, institutions, practices and processes developed by the international community to address global problems such as poverty, pandemics, global warming, displaced persons and transnational crim. Utilizes theories of decision- and policy-making and investigates the role of states, international governmental and non-governmental organizations, coalitions and corporations in global public policy-making. Pre: (IS 2054 or PSCI 2054 or GEOG 2054), (IS 2064 or PSCI 2064 or GEOG 2064). (3H,3C)

3154 (IS 3154): TOPICS IN GLOBAL PUBLIC POLICIES
Examines in depth selected global public policies pertaining to health, energy, development, education, refugees or labor. May be repeated with different content for a maximum of nine (9) credits. Pre: (IS 2054 or PSCI 2054 or GEOG 2054), (IS 2064 or PSCI 2064 or GEOG 2064). (3H,3C)

3165,3166 (IS 3165, 3166): GLOBAL ECONOMIC GOVERNANCE & POLICY
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance- Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations. Pre: IS 2064 or PSCI 2064 or GEOG 2064. (3H,3C)

3175,3176 (IS 3175, 3176): GLOBAL DEVELOPMENT
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world. Pre: (IS 2054 or PSCI 2054 or GEOG 2054), (IS 2064 or PSCI 2064 or GEOG 2064). (3H,3C)

3184 (IS 3184): HUMAN SECURITY
Introduces the field of human security and examines the conceptual, theoretical and methodological issues surrounding it. Identifies the relevant human security actors, explores the tools of human security, and discusses the application of human security. Investigates the implications of human security and

discusses its future. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3194 (IS 3194): NUCLEAR STRATEGY & POLITICS
Examines the fundamentals of nuclear strategy and investigates the politics associated with the acquisition and proliferation of nuclear weapons. Focuses on nuclear doctrines and policies and explores international efforts associated with nuclear arms control and disarmament. Analyzes the nuclear postures of various nuclear states. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3214: POLITICAL PARTICIPATION
Levels and types of political participation; reasons for participation; who participates and why; effects of political activity on political processes. Pre: 1014 or 1014H or 1024 or 1024H. (3H,3C)

3224: PUBLIC OPINION
Sources and distribution of public opinion; measurement of public opinion; relationships between public opinion and public policy; institutions linking public opinion to government decisions. Pre: 1014 or 1014H or 1024 or 1024H. (3H,3C)

3234: VOTING AND ELECTIONS
Voting, elections, and support for political parties and party leaders in the United States and other Western democracies; impact of economic conditions on political support and patterns of realignment and dealignment. Pre: 1014 or 1014H or 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3244 (COMM 3244): POLITICAL COMMUNICATION
Distribution of political information; elite-mass communication; alternative models of political communication; communication and telecommunications policy. Pre: 1014 or 1014H or 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3254 (COMM 3254): MEDIA AND POLITICS
Explore the role of the mass media in contemporary American politics by examining the development of media as sources of social and political influence. Study of news organizations, their coverage of electoral and issue campaigns, and their impact on candidates and voters. Includes the role of new technologies in campaigns. Pre: Junior Standing. (3H,3C)

3255,3256: THE POLITICS OF RACE, ETHNICITY AND GENDER
Studies the status and political behavior of selected political minorities. 3255: compares African-, Mexican- and Native-Americans. 3256: examines diverse political responses to traditional gender roles, current gender issues, and the unique gender problems facing people of color. Pre: 1014 or 1014H or 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3264: INTEREST GROUPS
Formation, structure, activities, and regulation of interest groups; comparison of American interest groups with those in other countries; evaluation of interest groups as participants in the political process. Pre: 1014 or 1014H or 1024 or 1024H. (3H,3C)

3274: POLITICAL PARTIES
Development, organization, activities, and personnel of political parties; citizens' partisan attitudes and behavior; origins, characteristics, stability, and changes of party systems. Pre: 1014 or 1014H or 1024 or 1024H. (3H,3C)

3314: CONGRESS
Congressional structure; organization and procedure; characteristics of members of Congress; Congressional elections; decision-making and external influences; change and reform. Pre: 1014 or 1014H. (3H,3C)

3324: THE PRESIDENCY
Election, institutionalization, staffing, relations with Congress, and the bureaucracy; initiation and implementation of public policy. Pre: 1014 or 1014H. (3H,3C)

3334: JUDICIAL PROCESS

Structure and functions of American legal institutions; participants in the process, impact of legal institutions on society. Pre: 1014 or 1014H. (3H,3C)

3344 (UAP 3344): GLOBAL ENVIRONMENTAL ISSUES: INTERDISCIPLINARY PERSPECTIVES
Critical examination of major global environmental problems (e.g., global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste) with emphasis on their social, economic, political, ethical, and policy implications and solutions. Pre: Completion of Area 4 of University Core. (3H,3C)

3354: CONSTITUTIONAL LAW: STRUCTURES AND RELATIONSHIPS
Power and authority of president, Congress, and courts; division of powers between states and federal government. Pre: 1014 or 1014H. (3H,3C) 3364: CONSTITUTIONAL LAW: CIVIL AND POLITICAL RIGHTS Civil rights and liberties; rights of criminal defendants; competing conceptions of constitutional rights. Pre: 1014 or 1014H. (3H,3C)

3414 (UAP 3434): PUBLIC ADMINISTRATION
The role and context of public administration in the contemporary United States, administrative organization and decision-making, public finance, human resources administration, and program implementation. Pre: 1014 or 1014H. (3H,3C)

3424: STATE AND LOCAL GOVERNMENT
Institutions, functions, and policies of state, county, and municipal governments in the U.S.; issues confronting these governments in the federal system. Pre: 1014 or 1014H. (3H,3C)

3434: URBAN POLITICS
Basic concepts of urban politics; governmental structures, policy processes, and political conflicts in U.S. cities, policy options for coping with urban problems. Pre: 1014 or 1014H. (3H,3C)

3444 (UAP 3444): ADMINISTRATIVE LAW AND POLICY
The legal context of the exercise of discretion by public administrators in the United States. Adjudication and rule- making; access to administrative processes and information; legislative and judicial control of administration. Pre: 1014 or 1014H. (3H,3C)

3514: LATIN AMERICAN GOVERNMENT AND POLITICS
Introduction to the political systems of Latin American countries, including legislative-executive relations, interest groups, political parties, electoral systems, political violence, and socio-political development. Pre: 1014H or 1014 or 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3515,3516: EUROPEAN POLITICAL SYSTEMS
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary. Pre: 1024 or 1024H. (3H,3C)

3524: POLITICS OF POST-COMMUNIST SYSTEMS
Institutions, party structures, political economy, elite politics, ethnic conflicts, leadership dynamics, and mass political behavior in Russia and other post-communist political systems. Pre: 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3534: AFRICAN GOVERNMENT AND POLITICS
Survey of major concepts and themes in the study of African politics and development: analyses of the state, political institutions, social forces, democratization, sustainable development, issues of contemporary African politics. Pre: 1024 or 1024H. (3H,3C)

3544 (JUD 3544) (RLCL 3544): THE STATE OF ISRAEL: A POLITICAL HISTORY
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political economy, etc. Pre: 1024 or 1024H or JUD 2134. (3H,3C)

3554: COMPARATIVE POLITICAL ECONOMY
Economic policies and collective choice processes of pre-industrial, industrializing, and advanced industrial states; problems and crises of industrial development, economic distribution, and technological transfer in the transition from an agrarian to advanced industrial society. Pre: 1024 or 1024H. (3H,3C)

3564: VIOLENT POLITICAL CHANGE
Historical origins, political processes, and institutional outcomes of violent political change, rising from mass protest movements, revolutionary organization, military coups, and radical political parties. Pre: 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3574: GOVERNMENT AND POLITICS OF JAPAN
Introduction to governmental institutions, patterns of political organization and behavior, and key policies of the Japanese political system. Pre: 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3584: GOVERNMENTS AND POLITICS OF ASIA
Introduction to governmental institutions, political behavior, and social and economic policy approaches of China and other selected countries in the Asian region. Pre: 1024 or 1024H or IS 1024 or IS 1024H. (3H,3C)

3615-3616 (IS 3615-3616): INTERNATIONAL RELATIONS
Structure and development of the modern international system; theories of international politics; international law; international organizations. Pre: IS 2054 or PSCI 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 for 3615; 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 for 3616. (3H,3C)

3624 (IS 3624): FOREIGN POLICY AND DIPLOMACY
Focuses on actors, issues, and processes pertaining to foreign policy formulation and implementation. Examines theoretical and historical perspectives on foreign policy analysis. Investigates the national security, foreign policy, and diplomacy nexus. Discusses types of diplomacy and diplomatic methods. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3625,3626 (IS 3625, 3626): US-RUSSIA FOREIGN POLICIES
3625: Formulation of American foreign policy; roles of the President, Congress, press, public, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology. Pre: 1024 or 1024H or IS 1024 or IS 1024H for 3625; 1024 or 1024H for 3626. (3H,3C)

3634 (IS 3634): HUMAN RIGHTS: GLOBAL ISSUES
Identification, articulation and clarification of the relationship between human rights and other contemporary international phenomena, issues, events, and processes that affect human rights. Detailed consideration of the diverse traditions and cultural interpretations of human rights. Pre: 1024 or 1024H or IS 1024 or IS 1024H or PSCI 2054 or IS 2054 or GEOG 2054. (3H,3C)

3684 (AINS 3684): INDIGENOUS PEOPLES AND WORLD POLITICS
A survey of the historical and contemporary struggles of indigenous peoples throughout the world. Examines the dynamics of colonialism (internal and external), identity construction, gender, cultural integrity, and the ongoing global indigenous rights discourse. In addition to covering broad global processes/theoretical approaches, comparative case studies of particular indigenous groups, such as the Maasai (Kenya, Tanzania) and Mayans (Mexico, Guatemala, Belize), are used to highlight the global, regional and intra-community diversity among contemporary indigenous peoples. (3H,3C)

3704 (IS 3704): NATIONAL SECURITY STRATEGY
Focuses on the causes of war and the conditions of peace. Examines the logic, levels, and outcomes of strategy and investigates the impact of international law and politics on the use of force. Explores contemporary strategic theory and discusses current issues in grand strategy. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3714 (UAP 3714): THE U. S. POLICY PROCESS

Description and analysis of the processes and institutions involved in the making and implementation of public policy in the United States, with a primary focus on domestic and economic policy. Empirical and normative models of the process of public policy making in the U.S. Pre: 1014 or 1014H. (3H,3C)

3724: POVERTY AND WELFARE POLICY
Public policies regarding the poor, impact of current policies; future policy options. Pre: 1014 or 1014H. (3H,3C)

3734 (IS 3734): NATIONAL SECURITY
Post-1945 strategic problems, policies, and security commitments of major participants in international politics, especially the United States and Russia; effects of security policies on international and domestic political economies. Pre: 2054 or IS 2054 or GEOG 2054. (3H,3C)

3735-3736 (IS 3735-3736): NATIONAL SECURITY POLICIES
Investigates the purposes, contexts and processes of national security policymaking both in the United States and in other states around the world. 3735: Focuses on Homeland Security. 3736: Focuses on Defense Policy. Pre: IS 2054 or PSCI 2054 or GEOG 2054 for 3735; IS 3735 or PSCI 3735 for 3736. (3H,3C)

3744 (UAP 3744): PUBLIC POLICY ANALYSIS
Methods and approaches used in the analysis and evaluation of public policy; strengths and limitations of various analytic tools; normative issues in the practice of policy analysis. Pre: 1014 or 1014H. (3H,3C)

3754: AMERICAN POLITICAL THEORY
American political theory from the pre-Revolutionary era to the present. American contribution to the understanding of freedom, equality, political community, constitutionalism, political dissent, and the welfare state. Pre: 1014 or 1014H. (3H,3C)

3764: CONTEMPORARY DEMOCRATIC THEORY
History and critiques of classical theories of democracy; contradictions within and contemporary problems facing democracy; future of democracy according to conservative, liberal, and radical theoretical perspectives. Pre: 2014, (3015 or PHIL 3015 or PSCI 3016 or PHIL 3016). (3H,3C)

3774 (UAP 3774): MARXIAN POLITICAL ANALYSIS
Contemporary uses of Marxian concepts and theories to study the world economy, business structure, current social issues, modern ethical values, and alienation. Pre: 2014, (3016 or 3554). (3H,3C)

3784: ORIGINS OF THE STATE
Theories of the origins of politics and government; evidence of state formation in prehistoric societies; political behavior in contemporary pre-literate societies as precursor to state formation. Pre: 2014, (3015 or 3016). (3H,3C)

3794 (IS 3794): TERRORISM AND COUNTERTERRORISM
Examines approaches to the categorizations and causes of terrorism and discusses national and regional understanding of terrorism. Explores official and popular understandings of terrorism over time and across regions and investigates how social actors legitimate their use of violence. Focuses on the development of useful counterterrorism policies and utilizes case studies in terrorism and counterterrorism to emphasize the link between theory and practice. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4024 (IS 4024): SEMINAR IN DIPLOMACY AND SECURITY
In-depth analysis of selected topics in diplomacy, strategy, and national security including issues pertaining to international conflict and cooperation; dimensions of national power; objectives of national policy and implementation of national strategy; diplomatic negotiations; and conflict resolution. Senior Standing. Pre: IS 2054 or PSCI 2054 or GEOG 2054. (3H,3C)

4034 (IS 4034): TOPICS IN DIPLOMACY LAB

Examines the fundamentals of policy analysis and formulation and emphasizes research and writing on topics pertaining to diplomacy, security, and foreign policy. Focuses on policy analysis and evaluation and concentrates on policy design. Emphasizes preparation and presentation of policy reports. May be taken three times for credit with different policy topics. Pre: Junior Standing. (3H,3C)

4054 (IS 4054): SEMINAR IN GLOBAL POLITICAL ECONOMY
Examines theoretical and historical approaches to global political economy and assesses their practical implications. Focuses on issue areas such as production, trade, money, finance and investment and analyzes their implications for the global economic and political order. Investigates issues pertaining to economies of development and in transition. Senior Standing. Pre: IS 2064 or PSCI 2064 or GEOG 2064. (3H,3C)

4064 (IS 4064): SEMINAR IN GLOBAL DEVELOPMENT
Examines how economic and political forces interact in the developing world, discusses the history of these interactions from the pre-colonial period to the present and explores how colonialism shaped the developing world's economic and political trajectories. Utilizes case studies, historical analysis and development economies to better understand the economic and political condition of countries in the developing world. Senior Standing. (3H,3C)

4074 (IS 4074): THE POLITICS OF CYBERSECURITY
Analyses the politics of cybercrime, cyberwar, and the challenges of producing effective cybersecurity. Topics include the economics of cybersecurity, the cross-border nature of global cybercrime, encryption and anonymity-granting technologies, targeting critical national infrastructure, network investigative techniques, cybersecurity measurement, politics of zero-day vulnerabilities, and the process of providing effective cybersecurity at the individual, organizational, subnational, and national levels. Pre: 3044 or IS 3044. (3H,3C)

4164 (BIT 4164) (CS 4164): FUTURE OF SECURITY: INTEGRATIVE SOLUTIONS FOR COMPLEX SECURITY SYSTEMS
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events. Pre: 2164 or BIT 2164 or CS 2164. (3H,3C)

4214: SENIOR SEMINAR IN POLITICAL BEHAVIOR
Political behavior: socialization, voting, opinion formation and expression, decision-making in government, as explained by personality, rationality, culture, class, and institutional roles. Topics vary from semester to semester as announced. Senior standing. Pre: 3214 or 3224 or 3234 or 3244 or 3264 or 3274. (3H,3C)

4314: SENIOR SEMINAR IN POLITICAL INSTITUTIONS
Selected topics in political institutions, including decision-making, types and structures of political institutions, internal and external influences on institutional behavior. Topics vary from semester to semester. Senior standing. X-grade allowed. Pre: 3314 or 3324 or 3334 or 3515 or 3516 or 3524. (3H,3C)

4324: SENIOR SEMINAR IN CONSTITUTIONAL LAW
Cases, law review articles, and related materials containing describing, or commenting on major decisions of the U.S. Supreme Court. Topics vary from semester to semester as announced. Senior standing. Pre: 3354 or 3364. (3H,3C)

4414: SENIOR SEMINAR IN PUBLIC ADMINISTRATION
Selected topics in public administration, including norms of practice, government personnel, administrative process, administrative law, privatizing, and contracting. Topics vary from semester to semester as announced. Must have senior standing. Pre: 3414 or 3424 or 3444. (3H,3C)

4514: SENIOR SEMINAR IN COMPARATIVE POLITICS

Selected topics in the comparative analysis of political behavior, processes, and institutions; cross-national institutional and aggregate data analysis. Topics vary from semester to semester as announced. Must have senior standing. Pre: 3515 or 3516 or 3524 or 3554 or 3564 or 3514 or 3534 or 3544 or 3574 or 3584. (3H,3C)

4614 (IS 4614): SENIOR SEMINAR IN INTERNATIONAL RELATIONS
Selected topics in international relations, including objectives of national policy, dimensions and components of national power, comparative diplomacy, international conflict and cooperation, instruments for conflict resolution. Topics vary from semester to semester as announced. Must have senior standing and any two of the prerequisites. Pre: 3615 or 3616 or 3625 or 3626 or 3734. (3H,3C)

4624 (UAP 4624): THE WASHINGTON SEMESTER: SEMINAR IN AMERICAN POLITICS AND PUBLIC POLICY
This seminar is the integrative forum for the principal elements of the Washington Semester experience. The course explores both the role of political institutions in policy formation and implementation and the primary managerial and leadership challenges that arise for implementing organization managers in American democratic public policy-making. Pre: Junior standing or instructor consent and acceptance into the Washington Semester program. X-grade allowed. (3H,3C)

4644 (UAP 4644): THE WASHINGTON SEMESTER: POLITICS, POLICY AND ADMINISTRATION IN A DEMOCRACY
This course is part of the Washington Semester. Explores the relationship between the imperatives of democratic mobilization, policy choices and organizational choices through intensive study of the operating context of a selected public or nonprofit organization. Examines implications of policy-maker choices for implementing institution dynamics and challenges. Pre: Junior standing and acceptance into the Washington Semester program required. X-grade allowed. Pre: 3714. (3H,3C)

4714 (IS 4714): SENIOR SEMINAR IN POLICY ANALYSIS
Theoretical, analytical, and methodological approaches used to assess government activities and public policy. Topics vary from semester to semester as announced. Must have senior standing. Pre: 3724, 3734. (3H,3C)

4724: SENIOR SEMINAR IN POLITICAL THEORY
Selected topics in analytic political philosophy, contemporary ideologies, and democratic theory. Topics vary from semester to semester as announced. Senior standing required. Must have senior standing and any two of the prerequisites. Pre: 3015 or PHIL 3015 or PSCI 3016 or PHIL 3016 or PSCI 3754 or PSCI 3764 or PSCI 3774 or UAP 3774. (3H,3C)

4734 (IS 4734): THEORIES AND PRACTICES OF INTERNATIONAL CONFLICT MANAGEMENT
Examines alternative perspectives on peace, security, and international intervention and their implications for policy. Focuses on the role international organizations and other actors in conflict resolution and peace-building and explores issues pertaining to humanitarian intervention, human security, and state-building. Utilizes case studies in peacekeeping and peace building to highlight the link between theory and practice. Pre: 3616 or IS 3616. (3H,3C)

4735,4736 (IS 4735, 4736): MULTILATERAL DIPLOMACY WORKSHOP
Investigates the purpose, context, and process of multilateral diplomacy and focuses on the strategies and tactics associated with it. Examines format and products of multilateral conferences, decision-making process, negotiations, mediation, delegation management, and conference management. Utilizes case studies and simulations. 4735: focuses on multilateral diplomacy at the United Nations. 4736: focuses on multilateral diplomacy in the framework of regional international organizations. Pre: IS 2054 or PSCI 2054 or GEOG 2054 for 4735; 2054 or IS 2054 or GEOG 2054 for 4736. (3H,3C)

4744 (IS 4744): INTELLIGENCE ANALYSIS WORKSHOP
Examines the impact of historical experience and bureaucratic structures on intelligence analysis. Discusses the contents of the intelligence agenda and explores issues pertaining to intelligence analysis. Focuses on the intelligence process and offers a target-centric approach to intelligence analysis. Emphasizes and evaluates the use of structured analytic techniques in intelligence analysis. Pre: IS 2054

or PSCI 2054 or GEOG 2054. (3H,3C)

4754: INTERNSHIP PROGRAM
Qualified students are placed in an administrative or legislative staff position under the combined supervision of a faculty member and a responsible supervisor in the employing agency. Detailed reports on the internship experience and a specific project will be required of each intern. (Variable credit to maximum of 6 credits for a full-time position over an entire semester). Three hours of appropriate advanced American government courses, Junior standing, a screening interview, GPA of 3.00 or better and consent required. Variable credit course. X-grade allowed.

4884 (ECON 4884) (PHIL 4884): ADVANCED TOPICS IN PHILOSOPHY, POLITICS, AND ECONOMICS
Advanced topics at the intersection of philosophy, politics, and economics. Core methods and concepts: utility theory, game theory, social choice theory, public choice theory, markets, justice, and democracy. Senior research project. Advanced discourse. Senior standing. Pre: PHIL 2894 or PSCI 2894 or ECON 2894. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

2019-2020 Undergraduate Course Catalog and Academic Policies

Psychology

Chair: Robert S. Stephens
University Distinguished Professor: T. H. Ollendick
Alumni Distinguished Professor: E. S. Geller
Heilig-Meyers Professor: R. A. Winett
Professors: M. A. Bell, W. K. Bickel, G. A. Clum, K. Deater-Deckard, J. W. Finney, and R. T. Jones
Associate Professors: D. K. Axsom, J. C. Dunsmore, R. J. Foti, B. H. Friedman, J. Germana, D. W. Harrison, R. J. Harvey, N. M. A. Hauenstein, J. Kim-Spoon, R. K. Pannenton, and A. Scarpa
Assistant Professors: M. T. Braun, A. D. Cate, P. Chiu, R. A. Diana, B. King-Casas, J. A. Richey, and S. W. White
Clinical Associate Professor: L. D. Cooper
Senior Instructor: K. A. Hoffman
Instructor: P. K. Harrison
Research Faculty: M. Cowart, K. Cuevas, C. T. Ramey, S. L. Ramey, and B. White
Affiliated Faculty: D. L. Brinberg, K. Carlson, B. Klein, T. Smith-Jackson, and D. G. Tatar
Adjunct Faculty: A. B. Allen, W. D. Crews, and R. W. Greene
Undergraduate Advising Coordinator: Cindy Koziol (231-5388)
Career Advisor: Kurt Hoffman (231-4005)

Web: **www.psyc.vt.edu**

Overview

The Department of Psychology offers an undergraduate program leading to the B.S. To graduate with a major in psychology, the undergraduate student must complete the Curriculum for Liberal Education (CLE) requirements of the College of Science and the following departmental requirements:
A minimum of 28 hours of psychology including Psyc 2004, 2094, and three 4000-level courses, at least one with laboratory (Psyc 4964, 4974, and 4994 are not counted as 4000-level courses for purposes of this requirement).

Successful completion of at least one three-credit course from the Statistics Department, except Stat 3104. Stat 2004, 3604, or 3615 are recommended. (NOTE: No credit will be given for Stat 2004 if taken with or after any other statistics course.)

In addition to courses used to fulfill the Scientific Reasoning and Discovery requirement (Area 4) of the CLE, two courses (6 semester hours) in one of the following areas: biological sciences, chemistry, physics. These additional courses need not be in the same discipline as courses used to satisfy Area 4 of the CLE.

Successful completion of two courses (6 semester hours) from the disciplines of computer science, philosophy, and/or statistics. These courses may either be in the same discipline or from any two of the three disciplines. Courses used to satisfy CLE requirements or other Psychology department requirements may not also be used to satisfy this requirement.

To graduate with a minor in psychology, the undergraduate student must complete 18 hours of psychology including Psyc 2004, 2094, and one 4000-level course (Psyc 2964 and 4964 may not be used toward the psychology minor).

A program leading to the B.S. in psychology "in honors" is available for eligible students. Additionally, opportunities are provided for students to engage in a directed program of independent research. The department sponsors a chapter of Psi Chi, the national psychology honor society, and the Psychology Club. Information about these and other activities is available at the Academic Advising Center Office (109 Williams Hall) in the Department of Psychology.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Psychology can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (BDS)

2005-2006: FUNDAMENTALS OF BEHAVIORAL DECISION SCIENCE
Introduction to the major scientific models of decision making and applications to real-life situations. Economic models highlighting optimal choices and psychological models highlighting decision making tendencies. 2005: Emphasis on individual decision making in non-strategic choice settings. Probabilistic reasoning and economic model of rationality. Violations of the rational choice model, and psychological, physiological, and statistical models that accommodate this behavior. Applications to social settings and longer periods of time. Common ethical dilemmas and making ethical choices as an individual. 2006: Individual decision making in interactive and strategic choice settings as well as group decision making. Simultaneous, sequential, dynamic, repeated, and incomplete information games. Preferences for fairness, reciprocity, and cultural differences in interactions. Limitations when making group decisions. Ethical reasoning and computational analysis of strategy. Applications to voting, negotiations, and cooperation. (3H,3C)

4194 (PSYC 4194): PREDICTING SOCIAL BEHAVIOR
Overview of the process of predicting human choices, preferences, and actions in social contexts. Applications of measurement theory to data preparation, formatting, and scaling. Implications of psychological biases for data transformation and cleaning. Theory-guided predictor variable selection and development. Applications of machine learning to social settings. Evaluating prediction quality, bias, and generalizability. Developing predictive models in software. Ethical and societal implications of predicting human behavior. Pre: (PSYC 1094 or ECON 3254), (BIT 2405 or STAT 2004 or STAT 3604 or STAT 3005 or ST AT 3615). (3H,3C)

Undergraduate Course Descriptions (PSYC)

1004: INTRODUCTORY PSYCHOLOGY
The scientific study of behavior, with a focus on behavioral research methods, analysis, theoretical interpretations, and applications. Survey of brain structures and their functions, sensory mechanisms, developmental processes, classical and operant conditioning, social processes and cultural norms, approaches to psychotherapy, stress and coping, and applications of psychological science. (3H,3C)

1024: PATHWAYS THROUGH AND BEYOND THE PSYCHOLOGY MAJOR
First Year Experience course introducing students to the psychology major. Discussion of university resources designed to promote student success. Emphasis on career exploration, and finding relevant research and field experiences outside the classroom. (2H,2C)

1094: PRINCIPLES OF PSYCHOLOGICAL RESEARCH
Philosophical foundation and ethical issues in psychological research. Research design and methodology. Analytic approaches to developing, understanding, interpreting psychological data. Pre: 1004 or 2004. (3H,3C)

1524 (ENGL 1524): LANGUAGE AND THE MIND
Examination of what is unique about human language and the evidence that language affects thought. Investigation of how listeners categorize sounds, parse sentences, and access meaning. Examination of what brain damage and speech errors reveal about language in the brain and mind. (3H,3C)

2014: PSYCHOLOGY OF SOCIAL INTERVENTIONS
An introduction to the psychological science that underlies behavioral interventions in non-clinical settings. Theories, methods, and applications as they relate to diverse domains such as health, education, prejudice reduction, and the environment. Methodological issues relating to intervention research in psychological science; understanding and limiting possible sources of bias. Relevance and limitations of psychological science for related public policy. (3H,3C)

2024: PSYCHOLOGY TRANSFER STUDENT COURSE
First Year Experience course introducing transfer students to the psychology major. Discussion of university resources designed to promote the successful transition from another school to Virginia Tech.

Emphasis on career exploration, professional development, and finding relevant research and field experiences outside the classroom. (1H,1C)

2034: DEVELOPMENTAL PSYCHOLOGY
Basic principles of human psychological development from the prenatal period through old age. Interactions between biological and environmental influences on the developing individual. Research methods in developmental science. Cultural influence on parenting practices, identity formation, and attitudes toward the elderly. Survey of recent literature within the areas of perceptual, cognitive, neurobiological, social, and emotional development. Pre: 1004. (3H,3C)

2044: PSYCHOLOGY OF LEARNING
Survey of fundamental concepts, phenomena, and principles of learning, such as reinforcement/punishment, classical conditioning, and cognitive explanations of retention/forgetting. Traditional learning research, with particular emphasis on methodology and ethical considerations. The behaviorist perspective, and neurobiological and cognitive approaches to understanding learning. The ethical and responsible use of animal models in learning research, and practical applications of learning theory. Pre: 1004. (3H,3C)

2054: PSYCHOLOGY OF PERSONALITY
Study of human personality and psychological adjustment: theory and research. Behavioral, cognitive, humanistic, and environmental determinants of personality. Psychological adjustment and personality development. Pre: 2004 or 1004. (3H,3C)

2064: INTRODUCTION TO NEUROSCIENCE OF BEHAVIOR
Introduction to biological factors that produce behavior. Neuroanatomy and neurophysiology. The development of the nervous system, and neuroplasticity. Basic neural processes involved in interpreting information, and making decisions. Conducting neuroscience research, and evaluating neuroscience-related claims in the popular media. The ethical and responsible use of nonhuman animal subjects; the ethical application of research findings in neuroscience to current problems such as psychopathy and neurodegenerative disease. Pre: 1004. (3H,3C)

2074: ANIMAL BEHAVIOR
Study of animal behavior: Comparative psychology and ethology, behavioral genetics, evolution of behavior, ecological aspects of behavior, predation, reproduction, and parental care. Some consideration is given to the relevance of animal behavior to human behavior. Pre: 2004 or 1004. (3H,3C)

2084: SOCIAL PSYCHOLOGY br> Introduction to the social behavior of the individual and the group: social perception and forming judgements of others, attitude formation and change, interpersonal attraction, applied psychology. Cultural influences on attitudes toward diversity, prosocial behavior, prejudice, and aggression and conflict. Application of psychological theories and research to address current social problems. Pre: 1004. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course. X-grade allowed.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3014: ABNORMAL PSYCHOLOGY
Survey of various types of psychological disorders and of contrasting theoretical views and representative

research on the etiology and prognosis of these disorders. Using the Diagnostic and Statistical Manual (DSM-5) to diagnose psychopathologies accurately. Ethical issues pertaining to clinical practice. Pre: 1004. (3H,3C)

3024: HUMAN BEHAVIORS AND NATURAL ENVIRONMENTS
Survey of the effects of natural and human-made environments on health and well-being. Historical changes in human-environment relations. Utilizing psychological research methods to investigate the possible impacts of urbanization on human health and well-being. The impacts of culture, region, and socioeconomics on how we utilize our environments, and our ability to change them. Research pertaining to our relationship with nature, use of natural resources, and strategies to encourage behaviors promoting environmental sustainability. Pre: 1004. (3H,3C)

3034: PSYCHOLOGICAL DISORDERS OF CHILDREN
An examination of theory, research, and practice as related to the assessment, treatment, and prevention of psychological disorders of children. Special emphasis on the understanding of child behavior disorders from a developmental, clinical-experimental point of view. Pre: (2004 or 1004), 3014. (3H,3C)

3054: HEALTH PSYCHOLOGY
Major theories, strategies, and methods for understanding psychological contributions to health and disease; psychological approaches to the treatment and prevention of disease and unintentional injuries, and health and safety promotion. Pre: 2004 or 1004. (3H,3C)

3094: ADVANCED RESEARCH METHODS IN PSYCHOLOGICAL SCIENCE
Advanced research and analytical methods. Emphasis on methods for specific research and/or practical questions, critical evaluation of research publications. Extended coverage of design and analysis principles and skills, selection and completion of appropriate statistical tests for given data sets. Student-driven empirical report including literature review, methods, analysis, interpretation, and implications for future research. PSYC majors only. Pre: (1094 or 2094), (STAT 2004 or STAT 3604 or STAT 3615). (3H,3C)

3154 (EDEP 3154): PSYCHOLOGICAL FOUNDATIONS OF EDUCATION
Emphasizes theories of human learning and the relationship of learning principles to educational practice. Within the context of both cognitive and behavioral models of learning, attention is given to instructional procedures, student motivation and discipline, and the assessment of educational progress. (3H,3C)

4014: HISTORY AND SYSTEMS IN PSYCHOLOGY
Overview of modern theories in psychology by consideration of current historical controversies. Traces roots of psychology in natural and social sciences. Considers the diversity of psychological study and the future of psychology. Senior standing in psychology required for undergraduate credit. Graduate standing required for graduate credit. (3H,3C)

4024: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY
Overview of psychological theories, research findings, and methods relevant to studying the behavior of individuals in organizations. Topics covered may include prediction of job performance, personnel testing, training and development, and leadership. Pre: (2004 or 1004), (STAT 2004 or BIT 2405 or STAT 3604 or STAT 3615). (3H,3C)

4034: SPECIAL TOPICS IN DEVELOPMENTAL PSYCHOLOGY
Rotating topics in the development of perceptual, cognitive, and socioemotional functioning throughout the life-span. In-depth, critical evaluation of current research literature and theory within various major age-spans. Developmental research methods, and research ethics. Cross cultural and contextual effects on development. May be repeated with different topics for a maximum of 6 credit hours. Pre: 1004, 2034, (1094 or HD 3014 or SOC 3204). (3H,3C)

4044: ADVANCED LEARNING
Critical analysis of basic paradigms of Pavlovian and Instrumental Conditioning with emphasis on general theories of learning and issues involved in cognition, reinforcement, and memory. Pre: 1004, 2044, (1094 or HD 3014 or SOC 3204). (3H,3C)

4054: PERSONALITY RESEARCH
Research techniques used in contemporary personality psychology: case histories, correlational methods, experimentation, archival studies, and psychobiography. Pre: 1004, 2054, (1094 or HD 3014 or SOC 3204). (3H,3C)

4064: PHYSIOLOGICAL PSYCHOLOGY
Presentation of concepts important for the study of neuroscience and behavior with a special emphasis on the classic topics of physiological psychology: brain-behavior relations, sensory integration, physiological correlates of motivation and emotion. Pre: 1004, (2064 or NEUR 2025), (PSYC 1094 or HD 3014 or SOC 3204). (3H,3C)

4074: SENSATION AND PERCEPTION
Overview of sensory and perceptual systems and their integration in influencing behavior. Emphasis on sensory receptor characteristics, neural structure, psychophysical data, perceptual phenomena and issues, theories about the human perceptual process. Pre: 1004, (2064 or NEUR 2025), (PSYC 1094 or HD 3014 or SOC 3204). (3H,3C)

4084: ADVANCED SOCIAL PSYCHOLOGY
Examines social behavior from four major theoretical orientations: reinforcement, field theory, cognitive, and role theory. Topics may include social learning, social exchange theories, group processes, attitude, and person perception. Pre: (2004 or 1004), 2084. (3H,3C)

4094: THEORY OF PSYCHOLOGICAL MEASUREMENT
Theory of psychological measurement and techniques used to develop and evaluate psychological measures. Coverage of standardization, measurement scales, reliability, validity, score transformations, composite scores, weighted scores, and test construction. Pre: 1004, 2034, (1094 or HD 3014 or SOC 3204), (STAT 2004 or STAT 3604 or STAT 3615 or BIT 2405). (3H,3C)

4114: COGNITIVE PSYCHOLOGY
An experimentally-oriented survey of human cognitive processes which include attention, memory, and decision making. Role of individual difference variables in each area. Pre: 1004, 2044, (1094 or HD 3014 or SOC 3204). (3H,3C)

4134 (ENGL 4134): LANGUAGE DEVELOPMENT
Survey of theories, mechanisms, and processes in human language development. Empirical overview of phonology, semantics, syntax, and pragmatics. Developmental trajectories of mono- and multilingual children. Cultural constraints on language. Perception of language and production of language, in typical and atypical subpopulations (e.g., hearing impairment). Junior/Senior Standing. Pre: 1004 or 2004. (3H,3C)

4194 (BDS 4194): PREDICTING SOCIAL BEHAVIOR
Overview of the process of predicting human choices, preferences, and actions in social contexts. Applications of measurement theory to data preparation, formatting, and scaling. Implications of psychological biases for data transformation and cleaning. Theory-guided predictor variable selection and development. Applications of machine learning to social settings. Evaluating prediction quality, bias, and generalizability. Developing predictive models in software. Ethical and societal implications of predicting human behavior. Pre: (1094 or ECON 3254), (BIT 2405 or STAT 2004 or STAT 3604 or STAT 3005 or STAT 3615). (3H,3C)

4214: COGNITIVE PSYCHOLOGY LABORATORY
Design, operation, and analysis of experiments to study human cognitive processes (e.g., attention, memory, and decision-making). Co: 4114. (3L,1C)

4234: LABORATORY IN DEVELOPMENTAL PSYCHOLOGY
Research design and implementation in the study of perceptual and motor development, language development, cognitive development, and social development. Pre: (2004 or 1004), 2034. Co: 4034. (3L,1C)

4244: LABORATORY IN ADVANCED LEARNING

Experimental techniques for studying the development, maintenance, and retention of behavior change in humans and animals. Laboratory exercises in Pavlovian and Instrumental Conditioning, verbal learning and memory. Co: 4044. (3L,1C)

4254: PERSONALITY RESEARCH LABORATORY
Laboratory course in personality research techniques. Emphasis on experimental, archival, questionnaire, and psychobiographical approaches. Co: 4054. (3L,1C)

4264: LABORATORY IN PHYSIOLOGICAL PSYCHOLOGY
Experimental techniques in the area of physiological psychology including: handling and care of laboratory animals, anesthetic and surgical techniques, and measurement of physiological variables. Co: 4064. (3L,1C)

4274: LABORATORY IN SENSATION AND PERCEPTION
Overview of the major experimental techniques and phenomena of sensation and perception. Emphasis on psychophysical methods, signal detection, dark adaptation, perceptual illusions. Co: 4074. (3L,1C)

4284: LABORATORY IN SOCIAL PSYCHOLOGY
Design, performance, and analysis of experiments in social psychology. Various methodologies used in social research (e.g., laboratory experimentation, field observations) will be studied through actual performance of experiments. Co: 4084. (3L,1C)

4294: LABORATORY IN PSYCHOLOGICAL MEASUREMENT
Design and implementation of psychological assessment devices including issues of test construction, reliability, validity, standardizing, and detecting test bias. Pre: (2004 or 1004), (2094 or 1094), (STAT 2004 or STAT 3604 or STAT 2405). Co: 4094. (3L,1C)

4354: SENIOR SEMINAR
For Psyc majors. Intended to provide in-depth coverage and discussion of a small set of topics selected by members of the seminar. Consent required. (3H,3C)

4364: SENIOR SEMINAR
For Psyc majors. Intended to provide in-depth coverage and discussion of a small set of topics selected by members of the seminar. (3H,3C)

4454 (ECON 4454) (NEUR 4454): NEUROECONOMICS
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics, policy, law and business. Pre: NEUR 2026 or ECON 3104. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course. X-grade allowed.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Program in Real Estate

Willis Blackwood Program in Real Estate Director: Kevin J. Boyle
Associate Director: Dustin Read
Manager of Academic Affairs and Business Operations: Christina Minford
Principle Faculty: D. Bieri - UAP, R. Dymond - CEE, J. Everett - REAL, E. Hopkins - PM, M. McMahon - AAEC, B. Murray - AAEC, D. Read - PM, J. Robert - REAL, M. Sirgy - MKTG, M. Walsh - REAL,, and C. White - CEE

Web: **www.realestate.vt.edu**

Overview

The Program in Real Estate is administratively housed in Pamplin College of Business. The B.S. in Real Estate is a comprehensive, interdisciplinary academic program that draws classes from five colleges (**College of Agriculture and Life Sciences**, **College of Architecture and Urban Studies**, **Pamplin College of Business**, **College of Engineering**, and **College of Liberal Arts and Human Sciences**) to students with dynamic education.

The Program in Real Estate offers a Bachelor of Science degree in Real Estate. Real Estate courses integrate the material students learn in disciplinary courses such as finance, law, and property management through practical experiences within the academic program. The integration occurs though a university-industry partnership where real estate professionals are actively involved in students' education through guest lectures, mentoring experiences, and by providing internship opportunities.

In addition to learning about the broad field of real estate, students are encouraged to find their niche in the field. Students develop an area of expertise to fulfill their restricted electives requirement. This is accomplished by adding a second major, completing a minor, or creating an area of concentration (with the

approval of their academic advisor) that meets each student's unique interests. Graduates of the Virginia Tech Program in Real Estate will be prepared to enter the Real Estate industry upon graduation and make immediate professional contributions.

Plan of Study

Note: Graduation requires a total of 120 semester credit hours. Requirements are subject to change; prospective students should contact their academic advisor prior to initiating their programs of study.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Remarks

Restricted Electives - Students must have a restricted elective plan of study signed by their real estate advisor comprised of courses that form a focused area of study in the real estate profession. Students may substitute courses from a second major or a minor for restricted electives as long as the courses are not real estate requirements (listed above).

Undergraduate Course Descriptions (REAL)

1004: DISCOVERING REAL ESTATE
First year experience for the Program in Real Estate. Academic planning, career exploration, and resources for academic success. Leadership, team building, communication and problem solving in the real estate industry. Role of ethics in the profession. Introduction to peer and professional mentors. (2H,2C)

1014: CAREERS IN REAL ESTATE
Provides an overview of multiple facets of the industry and highlights potential real estate careers. Examines academic training and specific skills needed to integrate knowledge from different real estate disciplines Provides an understanding of ethical leadership and pathways to achieve professional success through utilizing professional skills. Co: 2004 or UAP 2004. (1H,1C)

2004 (UAP 2004): PRINCIPLES OF REAL ESTATE
Introduction to real estate, including markets, land use planning and zoning, development, finance, construction, sales, marketing, management and property valuation. Examines the key actors and processes in each of these areas. Explores major public policies impacting real estate (3H,3C)

2024: PRINCIPLES OF REAL ESTATE SALES
Preparation for the Virginia Salesperson License Exam. Residential real estate sales, mortgages and deeds of trust, types of mortgages, liens, real property management, land use controls, deed restrictions, real estate laws, mandated disclosure, property tax and Real Estate Board Regulations. Pre: 2004 or UAP 2004. (1H,1C)

2034: REAL ESTATE DATA ANALYSIS
Overview of statistical analysis for use in the real estate market. Introduction of statistical tools and skills needed to draw conclusions from the data. Understanding data, coding and preparing the data, probability and inference, and special topics in inference including insights to inform ethical management and investment

decisions. Pre: UAP 2004 or REAL 2004, REAL 2014 or REAL 1014. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

3014: PROFESSIONAL DEVELOPMENT IN REAL ESTATE
Professional issues in the real estate industry such as interdisciplinary teamwork, ethics, and networking. Exposure to these topics through case studies, including presentations by real estate professionals. Pre: UAP 2004 or REAL 2004, REAL 2014 or REAL 1014. (1H,1C)

3024: APPLIED REAL ESTATE DEVELOPMENT
Examines real estate development from design and construction through asset management. Develops analysis tools based on comprehensive plans and regulations, conceptional design, market analysis, design aspects of products, security financing and sustainability. Categorizes construction contracts, zoning, leasing and property management. Determine sustainability and observe various stakeholders. Pre: (UAP 2004 or REAL 2004), REAL 2014, REAL 2034. Co: 3044. (3H,3C)

3034 (MKTG 3034): REAL ESTATE MARKET ANALYSIS
Market potential of residential, retail, office and industrial, hotels and resorts, and mixed use real estate development projects. Market analysis, identifying a market area, conducting demand and supply analyses, reconciling demand and supply. Pre: 2034, (ECON 2005 or AAEC 1005). (3H,3C)

3044 (FIN 3044): FINANCING REAL ESTATE PROJECTS
Methods and tools for analyzing commercial real estate from the perspective of a developer. Land valuation, equity and debt financing, measuring project returns, public private partnerships, and real estate capital markets. Pre: 2034, AAEC 1005 or ECON 2005. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4064: REAL ESTATE APPRAISAL
Application of economic principles to the valuation and appraisal of property including statistical analysis. Cost approach, sales comparison approach and income capitalization approach to conducting appraisal. Appraisal report for evaluating rural property, commercial, residential and transitional. Ethical and professional requirements. Pre: Senior standing. Pre: 3044. (3H,3C)

4075-4076: REAL ESTATE STUDIO
Course provides mock, real-world learning in a student-led, team environment. Teams will analyze, design and develop a plan, for a mixed use or complex real estate development. Project spans two semesters. Students select a team project in consultation with faculty and industry advisors. Work will focus on all elements of preliminary design and approvals required to initiate a real-world development. For majors only. Pre: 3024 for 4075; 4075 for 4076. (1H,6L,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Department of Religion and Culture

Chair: Matthew Gabriele
Professors: B. Britt, M. Gabriele, S. Johnson, and M. Saffle
Associate Professors: A. Abeysekara, A. Ansell, Z. Ni, A. Puckett, E. Satterwhite, P. Schmitthenner, and R. Scott
Assistant Professors: A. Armstrong, D. Christensen, S. Patel, and B. K. Singh
Postdoctoral Fellow: M. Case
Research Associate: D. Polanco
Instructor: J. Laney

Web: http://liberalarts.vt.edu/rlcl

Overview

The Department of Religion and Culture critically investigates religion, culture, and their relationships by problematizing what is commonly considered self-evident, especially since these subjects are intrinsic to

understanding the human condition both locally and globally. In our research, teaching, and engagement, we seek to craft and apply new forms of critical inquiry that advance integrative intellectual thought. These paths of inquiry inform our engagement with students, who become well prepared to understand complex transformations throughout their lives, whether they pursue graduate studies or other life trajectories.

The department offers undergraduate degrees in Religion and Culture (RLCL) and Humanities for Public Service (HPS) and minors in American Studies, Appalachian Studies, Judaic Studies, Medieval and Early Modern Studies, Middle East Studies, Popular Culture, and Religion.

The department also offers an M.A. in Material Culture and Public Humanities, two graduate certificates--one in Religious Studies and the other in Material Culture and Public Humanities; and is a core member of the Alliance for Social, Political, Ethical, and Cultural Thought (**ASPECT**) Ph.D. program.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Religion and Culture Major (RLCL)

The Bachelor of Arts degree in Religion and Culture (RLCL) combines the strengths of the department in the areas of the humanities and study of religion in order to provide students with opportunities to examine several of the twenty-first century's most important global phenomena. Students completing this cutting-edge, one-of-a-kind degree will explore the impact of religious and cultural practices on politics, economics, the arts, and everyday life (including pop culture), as well as the impact of these practices on moral and ethical practices in today's world. Graduates will be prepared to contribute as employees and citizens to the state of Virginia, the United States, and indeed the world as all levels of society seek better ways to live and work together in the increasingly diverse contexts of the twenty-first century. Religion and culture shape the world and will continue to do so in dramatic and changing ways.

Students who choose this major will develop complex problem-solving skills, alongside critical thinking that will prepare them for a wide range of careers. The global focus of the major affords career opportunities in education, business, government, many private industries, and the non-profit sector. The major has a strong academic and career-advising component.

Humanities for Public Service Major (HPS)

Students in the major, Humanities for Public Service, build a strong foundation in humanistic learning about cultural and religious traditions with the aim of preparing for careers in public service. The major option cultivates cultural awareness and critical thinking skills, familiarizing students with the ways that people have conceptualized, encoded, and reflected on human experience. Therefore it prepares them to sensitively and thoughtfully work for the public good. Requirements include selected courses in both theory and applicaton, as well as a field study/internship.

Study Abroad

Students are strongly encouraged to complete an approved study abroad program outside of the U.S. Study abroad programs are occasionally run by faculty in the department.

Honors College

Eligible students are encouraged to participate in the University Honors Program. Completing a degree "In Honors" is an excellent way for outstanding students to integrate the knowledge from several disciplines. Honors students have considerable flexibility in completing the degree requirements.

Double Majors

For information on earning a double major or second degree, contact the Department Chair. Since Religion and Culture major is flexible and dynamic, students are encouraged to earn a second major.

Religion and Culture Minors

The department offers the following minors. Please contact our undergraduate advisor, Amanda Villar (**avillar@vt.edu**), for more information.

- American Studies
- Appalachian Studies
- Judaic Studies
- Medieval and Early Modern Studies
- Middle East Studies
- Popular Culture
- Religion

American Studies

American studies is an interdisciplinary field that draws upon a number of academic disciplines, including history, literature, and sociology, to consider relationships between culture and society in the United States as it is embedded in global processes and issues.

Appalachian Studies

Appalachian Studies is an academic program supporting teaching, research, outreach, and service on topics pertaining to Appalachia in relation to pertinent transglobal issues. Appalachian Studies faculty focus on these issues from a critical regionalism perspective in which the relationship between these issues and region is considered problematic and open to investigation.

Judaic Studies

Endowed in 1996, the Malcolm and Diane Rosenberg Program in Judaic Studies offers students the opportunity to explore, examine, and critically engage the rich and multifaceted history, religion, and culture of the Jewish people. Judaic culture has significantly contributed to Western and other civilizations.

Medieval and Early Modern Studies

Medieval & Early Modern Studies fosters an interdisciplinary approach to the Medieval and Early Modern Worlds (roughly 300-1700 C.E.).

Middle East Studies

The interdisciplinary minor in Middle East Studies allows students to gain a broad understanding and appreciation of the languages, religions, and cultures of the Middle East and of the region's history and its place in international relations.

Popular Culture

The Minor in Popular Culture provides an understanding of the broadly shared cultures made possible by mass production. Popular culture includes all widely practiced and distributed expressions: news; entertainment; religion; sports; popular art; and styles of decoration, dress, and architecture.

Religion

By examining a diversity of traditions and viewpoints, a program in religious studies provides the resources for an intellectually responsible appraisal of one's own value commitments. A minor in Religion is part of a broad liberal arts education and may lead to graduate study in a variety of fields or to professional training in ministerial or social service vocations.

Undergraduate Course Descriptions (APS)

1704 (HUM 1704): INTRODUCTION TO APPALACHIAN STUDIES
Introduces students to the history of the Appalachian region from European contact to the present. Traces the idea of Appalachia by tracing ways in which Americans have imagined the region over time. Explores humanistic problems of cultural identity, race and ethnicity, place and globalization, and impacts of natural resource extraction. (3H,3C)

2124 (MUS 2124): MUSIC TRADITIONS IN APPALACHIA
Survey and study of music traditions in Appalachia. Investigation of the formal elements of this music, including instruments and musical terms and forms. Exploration of style as a reflection of many cultural influences. Study of the impact and development of these traditions in contemporary musical practices. (3H,3C)

2404 (HUM 2404): FOLK CULTURES IN APPALACHIA
Examination of the expressive genres and cultural processes of communities in Appalachia. Documentation of art and skill in everyday life, including material culture (e.g., foodways, architecture), customary behavior (e.g., music, ritual, occupational practice), and verbal art (e.g., narrative, speechplay), and analysis of how people have used these forms to shape social identities, physical spaces, and power relations. (3H,3C)

2434: THE CULTURAL POLITICS OF MUSIC IN APPALACHIA
Examines cultural, political, and social aspects of music in, of, and about Appalachia, including such commercialized and increasingly globalized products as "old-time", "bluegrass", and "country". Ways in which music contests and reproduces social relations of race, class, and gender. Role of migration and racial diversity in formation of Appalachian music. Economic significance of music, such as Virginia's The Crooked Road as a regional touristic undertaking. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3464 (AHRM 3464) (GEOG 3464) (HD 3464) (HUM 3464) (SOC 3464) (UAP 3464): APPALACHIAN COMMUNITIES
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4034 (SOC 4054): APPALACHIAN LANGUAGES AND CULTURES
An empirical examination of how Appalachian speech both reflects and constitutes regional cultures. Emphasis is on applying sociological and anthropological methods and theories to the study of language in use. (3H,3C)

4094 (PHS 4094) (SOC 4094): APPALACHIAN COMMUNITY RESEARCH
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy. (3H,3C)

4414 (HUM 4414): ISSUES IN APPALACHIAN STUDIES
Research conducted by students on issues relevant to local or regional sustainability in contemporary Appalachia on contemporary environmental and community issues. Focus on environmental justice ethical issues expressed in or created by various forms of discourse. Pre: HUM 1704 or APS 1704. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors Variable credit course.

Undergraduate Course Descriptions (HUM)

1324: INTRODUCTORY HUMANITIES: THE MODERN WORLD
The shifts in thought and values during the nineteenth and twentieth centuries in the global imagination, including issues of commerce, scientific inquiry, industrialization, nationalism, war, labor, gender, class differences, race, and the beginnings of postmodernity. Emphasis on interpretive and analytic skills in terms of reading, discussing, and writing about the interrelationships among the arts, literature, philosophy, history, religion, and science, and their contributions toward shaping the values and aspirations of the age, including global contexts and Asian cultures. (3H,3C)

1604: INTRODUCTION TO HUMANITIES AND THE ARTS
Explores the written, visual, and performing arts of selected periods and cultures, setting them in the context of their times. Study of these periods linked with overarching questions of cultural encounters, interactions, and negotiations. Introduces principles of each art form as well as the means of appreciation. Students taught methods in researching, writing, and presenting on these art forms. (3H,3C)

1704 (APS 1704): INTRODUCTION TO APPALACHIAN STUDIES
Introduces students to the history of the Appalachian region from European contact to the present. Traces the idea of Appalachia by tracing ways in which Americans have imagined the region over time. Explores humanistic problems of cultural identity, race and ethnicity, place and globalization, and impacts of natural resource extraction. (3H,3C)

2104 (AINS 2104): ORAL TRADITIONS AND CULTURE
Examination of the world's great oral traditions, both ancient and contemporary. Emphasis on performance

contexts, relationships among multicultural traditions, including American Indian oral traditions, and the relationships among orality, literacy, technology, media, and culture. (3H,3C)

2204: THE CREATIVE PROCESS
Explores ways in which creativity and design can be understood historically as well as understood and practiced in a classroom setting. Subjects include any or all of the following: theories of creativity; traditions associated with understanding and making several kinds of art; studying artworks from different cultural backgrounds, working with the limitations and possibilities inherent in design projects, and examining how and why they were created; and preparing final creative projects for classroom presentation. (3H,3C)

2404 (APS 2404): FOLK CULTURES IN APPALACHIA
Examination of the expressive genres and cultural processes of communities in Appalachia. Documentation of art and skill in everyday life, including material culture (e.g., foodways, architecture), customary behavior (e.g., music, ritual, occupational practice), and verbal art (e.g., narrative, speechplay), and analysis of how people have used these forms to shape social identities, physical spaces, and power relations. (3H,3C)

2504 (RLCL 2504): INTRODUCTION TO AMERICAN STUDIES
Methodology and tools of American studies, with a focus on developing analytic skills to assess discourse across varied media. Interdisciplinary investigation of histories, politics, cultures, and beliefs in the Americas, including the impacts of encounter and exchange. Intensive study of a specific topic or period. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3034 (RLCL 3034): THEORIES OF POPULAR CULTURE
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States. (3H,3C)

3034H (RLCL 3034H): THEORIES OF POPULAR CULTURE
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States. (3H,3C)

3044: TOPICS HUMANITIES AND ARTS
Focuses on interdisciplinary topics involving interrelationships among various arts and/or artists. Explores the religious and/or cultural impacts of arts and/or artists on societies and of societies on artistic expression. Investigates humanistic debates about the nature of art. May be taken a maximum of 3 times for credit with different topics. (3H,3C)

3204 (RLCL 3204): MULTICULTURAL COMMUNICATION
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants. (3H,3C)

3464 (AHRM 3464) (APS 3464) (GEOG 3464) (HD 3464) (SOC 3464) (UAP 3464): APPALACHIAN COMMUNITIES
The concept of community in Appalachia using an interdisciplinary approach and experiential learning.

Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4034 (RLCL 4034): FUNCTIONS OF POPULAR CULTURE
Popular culture as a humanistic discipline; emphasis on archetypes, formulas, and genres; the function of ideas, images, and icons on the popular imagination. (3H,3C)

4104 (RLCL 4104): EXPLORATIONS IN ADVANCED HUMANITIES TOPICS
In-depth study of special interdisciplinary topic. Topics vary but involve a close and extensive study of the interrelationship between cultural ideas and their expressions in several of the following forms: literature, philosophy, religion, art, music, drama, material culture, and popular culture. May be repeated with different topics, for a maximum of 9 credits. (3H,3C)

4414 (APS 4414): ISSUES IN APPALACHIAN STUDIES
Research conducted by students on issues relevant to local or regional sustainability in contemporary Appalachia on contemporary environmental and community issues. Focus on environmental justice ethical issues expressed in or created by various forms of discourse. Pre: 1704 or APS 1704. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (JUD)

1105-1106 (HEB 1105-1106): ELEMENTARY MODERN HEBREW
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases. (3H,3C)

2134 (RLCL 2134): JUDAISM: A SURVEY OF HISTORY, CULTURE, AND HERITAGE
Introduction to the academic study of Judaism; a variety of scholarly approaches to Jewish textual and cultural sources, including the Hebrew Bible, rabbinic literature, and diverse contemporary cultural, religious, and social expressions. Emphasis on developing skills in critical thinking, reading, and writing about Judaism as a way of understanding the beliefs, philosophies, and histories of global Jewish communities past and present. (3H,3C)

2414 (RLCL 2414): HEBREW BIBLE/OLD TESTAMENT
Introduction to the academic study of the Hebrew Bible (Old Testament), including its contents, contexts, major themes, and reception; a variety of scholarly approaches, including historical-critical, literary, ethical, and gender studies methods. Emphasis on developing skills in critical thinking, reading, and writing about the

Hebrew Bible (Old Testament). (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3404 (RLCL 3404): TORAH AND TRADITION
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament and beyond. Pre: REL 2414. (3H,3C)

3494 (HIST 3494) (RLCL 3494): THE HOLOCAUST
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovah's Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, personal testimony. (3H,3C)

3544 (PSCI 3544) (RLCL 3544): THE STATE OF ISRAEL: A POLITICAL HISTORY
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political economy, etc. Pre: 2134 or PSCI 1024. (3H,3C)

4424: ADVANCED TOPICS IN JEWISH CULTURE, HISTORY & THOUGHT
Selected topics in Jewish culture, history and thought. Possible topics includes: the philosophy of Maimonides, Spinoza or Buber, or a course dedicated to one of the following topics: Kabbalah, Hasidism, The American Jewish experience in the first half of the 20th century, and Oriental Jewish art and folklore. Two JUD courses or senior standing required. Alternate years. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (RLCL)

1004: INTRODUCTION TO RELIGION AND CULTURE
This course introduces students to foundational concepts and debates within the humanities and social sciences by studying one of a rotating set of themes (e.g. love, evil, apocalypse) located at the intersection of religion and culture. Emphasis on cultural diversity, historical transformation, interdisciplinary inquiry, problem-solving and the application of academic discussions to everyday life situations. (3H,3C)

1004H: INTRO TO RELIGION & CULTURE
This course introduces students to foundational concepts and debates within the humanities and social sciences by studying one of a rotating set of themes (e.g. love, evil, apocalypse) located at the intersection of religion and culture. Emphasis on cultural diversity, historical transformation, interdisciplinary inquiry, problem-solving and the application of academic discussions to everyday life situations. (3H,3C)

1024: JUDAISM, CHRISTIANITY, AND ISLAM
Nature of religion and the analysis of it from an academic perspective. Basic tenets of Judaism, Christianity, and Islam, including their manifestations in the United States and their involvement in critical issues in a global context Interpretation of key texts from various historical and cultural contexts. (3H,3C)

1024H: JUDAISM, CHRISTIANITY, ISLAM
Nature of religion and the analysis of it from an academic perspective. Basic tenets of Judaism, Christianity, and Islam, including their manifestations in the United States and their involvement in critical issues in a global context Interpretation of key texts from various historical and cultural contexts. (3H,3C)

1034: RELIGION AND THE MODERN WORLD
Modern challenges to traditional religion and responses to these challenges, including: religion as an object of critique; law, sovereignty, and religion; religion, gender, and race; religion, science, and technology; religion and media presentations. (3H,3C)

1034H: RELIGION AND THE MODERN WORLD
Modern challenges to traditional religion and responses to these challenges, including: religion as an object of critique; law, sovereignty, and religion; religion, gender, and race; religion, science, and technology; religion and media presentations. (3H,3C)

1044: RELIGIOUS ETHICS
Influential representative social and religious ethical perspectives from ancient Greek philosophers to the present; ethical reasoning on current pressing and perennial social issues - bioethics, sexuality, family, poverty-- based on historical and ethical analysis of case studies; theoretical assumptions about morality as the relation between living a virtuous life and performing ethical duties. (3H,3C)

1134 (CLA 1134): THE ANCIENT MEDITERRANEAN WORLD
Ancient cultures of the Mediterranean world with a focus on their embodiments in the arts, literature, history, philosophy, and religion. Emphasis on Greek, Hellenistic and Roman cultures, their interrelationships with each other and their historical, cultural, material and intellectual encounters with contemporary Mediterranean cultures as well as their influence on later and modern cultures. (3H,3C)

1214: THE MEDIEVAL WORLD
Introduction to Europe and the Mediterranean world in the period between antiquity and the European encounter with the Americas. Investigation of the arts, literature, philosophy, and history of the period in the Christian, Jewish, and Islamic traditions and the multiple types of encounters that those communities experienced. Analysis of the impact the medieval world continues to have on the modern West. (3H,3C)

1904: RELIGION AND CULTURE IN ASIA
Historical and geographical overview of diverse religious/cultural traditions in Asia, such as Hinduism, Buddhism, Sikhism, Confucianism, Daoism, and Shinto. Investigation of the categories "religion" and "culture" and their interactions in Asia. Examination of different methodological and interdisciplinary approaches and their integration, with emphasis on critical thinking about the complexities of studying religion and culture in Asia. Asia on a global stage, including Western views of Asia and Asian views of the West. (3H,3C)

1904H: RELIGION AND CULTURE IN ASIA
Historical and geographical overview of diverse religious/cultural traditions in Asia, such as Hinduism, Buddhism, Sikhism, Confucianism, Daoism, and Shinto. Investigation of the categories "religion" and "culture" and their interactions in Asia. Examination of different methodological and interdisciplinary approaches and their integration, with emphasis on critical thinking about the complexities of studying religion and culture in Asia. Asia on a global stage, including Western views of Asia and Asian views of the West. (3H,3C)

2004: CASE STUDIES IN RELIGION AND CULTURE

Significant case studies in the study of religion and culture with an emphasis on influential and emerging research. Focused engagement with humanities and social sciences research grounded in analysis, comparison, and evaluation of relevant case studies. (3H,3C)

2054 (SOC 2054): ETHNOGRAPHY: STUDYING CULTURE
Introduction to the methodological tools used by anthropologists and other social scientists to study culture. Engagement with the development of, and debates about, ethnographic methods, as well as their application to case studies. Focus on sample ethnographic accounts of peoples throughout the world, as well as research techniques applicable to many different cultural environments. (3H,3C)

2104 (GR 2104): GREEK NEW TESTAMENT
Readings from the New Testament in Greek, with attention to grammatical analysis, historical background and other clues interpretation. May repeated with different content for a maximum of 9 credits. Pre: GR 1106. (3H,3C)

2124: RELIGION IN AMERICAN LIFE
Understanding and integrating source materials for the study of religion in American life. Genealogy of religion and culture in America (USA). Changes and transformations in religious beliefs and practices and their influences on American life. Debates about religion and culture. Entanglements of religion, politics, race, ethnicity, and law. (3H,3C)

2134 (JUD 2134): JUDAISM: A SURVEY OF HISTORY, CULTURE, AND HERITAGE
Introduction to the academic study of Judaism; a variety of scholarly approaches to Jewish textual and cultural sources, including the Hebrew Bible, rabbinic literature, and diverse contemporary cultural, religious, and social expressions. Emphasis on developing skills in critical thinking, reading, and writing about Judaism as a way of understanding the beliefs, philosophies, and histories of global Jewish communities past and present. (3H,3C)

2144 (AFST 2144): AFRICAN RELIGIONS
The role of religious (or belief) systems in African societies, especially the three predominant religious traditions in Africa: the so-called African Traditional Religious, Islam, and Christianity; the universe of religious systems and religious experiences and processes of Africa, in particular, Sub-Saharan Africa; critical examination of the mythic stature of Africa's "religions" within Western cultural (and scholarly) world views and institutions. (3H,3C)

2204 (AFST 2204) (WGS 2204): RACE AND GENDER IN RELIGION AND CULTURE
Influence of race and gender on religion and culture. Overview of approaches to categories of diversity, particularly race and gender, in religious and cultural traditions. Utilization of humanistic and social scientific approaches to investigate geographically variable historical and/or contemporary case studies. (3H,3C)

2324: ISLAM
Addresses the rise of Islam under the Prophet Muhammad in Arabia, the development of Islam in the Middle Ages, and its resurgence in the 20th century. Issues of geographical, temporal, and ideological diversity, and critical thinking about representations of Islam in the West. Islamic orthodoxy addressed by examining the question of who represents Islam, when, and how. (3H,3C)

2374 (HIST 2374): GODS AND KINGS IN PREMODERN INDIA
History of India from pre-historical times to approximately 1700, with particular focus on the interplay between religion and politics. Emphasis on sources for and interpretations (historiography) of early Indian history. Literary versus archaeological record of pre-historic India, the earliest empires and rulers, and impact of the Islamic and wider world on India. Legacies of ancient and medieval India in the contemporary world. (3H,3C)

2384 (HIST 2384): GANDHI IN THE MAKING OF MODERN INDIA
History of India since approximately 1700, with particular focus on Gandhi's influence on modern India and the world. Emphasis on sources for and interpretations (historiography) of modern Indian history. Examination of pre-colonial and colonial pasts and legacies. Exploration of Gandhi's role in political, social, cultural, and religious movements of the early 20th century, and Gandhi's legacy in the independent states of South Asia and the contemporary world. (3H,3C)

2414 (JUD 2414): HEBREW BIBLE/OLD TESTAMENT
Introduction to the academic study of the Hebrew Bible (Old Testament), including its contents, contexts, major themes, and reception; a variety of scholarly approaches, including historical-critical, literary, ethical, and gender studies methods. Emphasis on developing skills in critical thinking, reading, and writing about the Hebrew Bible (Old Testament). (3H,3C)

2424: NEW TESTAMENT
Introduction to the academic study of the New Testament, including gospels, Pauline materials, theological themes, and sources on the emerging church. A variety of scholarly approaches to the New Testament texts and contexts, including historical-critical, redaction critical, and literary methods. Emphasis on developing skills in critical thinking, reading, and writing about the New Testament and the ancient Mediterranean world as a way of understanding the religion and history of early Christianity. (3H,3C)

2444 (CLA 2444) (ENGL 2444): GREEK AND ROMAN MYTHOLOGY
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English. (3H,3C)

2464 (STS 2464): RELIGION AND SCIENCE
Exploration of the relationships between religion and science in the western tradition. Basic frameworks for relationships between religion and science in historical and cultural context, types of human knowledge and truth, similarities and differences between science and religion, evolution, the origins of the creationist movement, and contemporary moral and ethical issues. (3H,3C)

2474 (IS 2474): RELIGION AND VIOLENCE
Investigation of the categories of religion and secularity as they apply to war and peace. Analysis of episodes from both past and present in which religion seems to have played a role. Introduction to research skills related to the study of religion and violence, building from theoretical and historical considerations. (3H,3C)

2504 (HUM 2504): INTRODUCTION TO AMERICAN STUDIES
Methodology and tools of American Studies, with a focus on developing analytic skills to assess discourse across varied media. Interdisciplinary investigation of histories, politics, cultures, and beliefs in the Americas, including the impacts of encounter and exchange. Intensive study of a specific topic or period. (3H,3C)

2514 (SOC 2514): ASIAN AMERICAN EXPERIENCE
Interdisciplinary overview of the diverse Asian American experience, incorporating non-Eurocentric perspectives on the Asian immigrant experience and dialogue between Asian American and non-Asian American students. Examination of different historical tracks of various Asian ethnicities, experience of racism, discrimination, cultural adaptation and conflict, and economic survival and success. Gender, age, religious affiliation, family values and inter- generational differences among Asian Americans. The complexity of minority status and the stereotype of "model minority." Activism, political participation, leadership and the meaning of citizenship among Asian Americans. Representations of Asian Americans in the arts and media. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3014 (WGS 3014): WOMEN AND GENDER IN ISLAM

An examination of women and gender in Islam from a variety perspectives including Muslim women in Islamic history, normative constructions of the role of women in Islam, and women's roles in contemporary Muslim societies. Understanding of women in classical Islam; feminist and reformist approaches; and Western constructions of the "rights of women if Islam." (3H,3C)

3024 (ENGL 3024): RELIGION AND LITERATURE
Read works from world literature, guided by selected critical readings. Compare/contrast diverse models of "religion" and "literature." Study how modernity has impacted traditions of religion and culture. Interpret literary texts that draw from multiple religions. Analyze religion-literature controversies in a range of social, cultural, political contexts. Synthesize sources of multiple media, formats, and contexts. (3H,3C)

3034 (HUM 3034): THEORIES OF POPULAR CULTURE
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States. (3H,3C)

3034H (HUM 3034H): THEORIES OF POPULAR CULTURE
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States. (3H,3C)

3144 (ENGL 3144) (SOC 3144): LANGUAGE AND ETHNICITY IN THE UNITED STATES
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

3204 (HUM 3204): MULTICULTURAL COMMUNICATION
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants. (3H,3C)

3214: RELIGION AND CULTURE IN INDIA
Interdisciplinary examination of the genealogy of Indian religions (including Hinduism, Buddhism, Jainism, and Sikhism) through anthropological, literary, historical, and textual source materials. Colonial construction and reform of these religions according to modern, "universal" European ideas of religion; how European notions of the modern nation-state, law, and religious tolerance, and European concepts of self, autonomy, community, (univocal) language, and multiculturalism impacted Indian religions. Pre-modern versus modern notions of tradition and power in Indian religions. Concepts of secularism, gender, race, conversion, caste, and religious-political identity. (3H,3C)

3224: RELIGION AND CULTURE IN CHINA AND JAPAN
Premodern model of Chinese and Japanese religions: interactions of various traditions (e.g. Confucianism, Buddhism, Daoism, Shinto, and folk); inseparability of religion, culture, society, and politics. Modern reinventions of religion in China and Japan in the late nineteenth and early twentieth centuries. Contemporary issues such as state-religion relations in East Asia, religions of China and Japan in America, East Asian religions and globalization. (3H,3C)

3404 (JUD 3404): TORAH AND TRADITION
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond. Pre: 2414. (3H,3C)

3414: JESUS IN EARLIEST CHRISTIANITY
Literary survey of the various representations of Jesus of Nazareth in canonical and apocryphal Christian literature of the first four centuries. Perspectives on Jesus and the interpretive authority involved in producing

such variety. Ancient and modern interpretive frameworks for understanding the person and legacy of Jesus in earliest Christianity, including historical-critical frameworks, redaction criticism, genre criticism, and other literary methods. Analyses of modern religious/political discourses as continuations of ancient theological debates. Emphasis on developing skills in critical thinking and close reading of early Christian texts as a means of understanding the religion(s) and histories of the earliest Christians. (3H,3C)

3424: ORTHODOXY AND HERESY IN EARLY CHRISTIANITY
Literary survey focusing on the diversity of Christian beliefs in the first four centuries. Highlights a variety of theological debates and the historical and cultural contexts involved in the eventual production of a Christian orthodoxy, over and against so-called heresy. The history and content of early Christian texts, both canonical and apocryphal. Ancient and modern interpretive frameworks for understanding the variety and diversity of earliest Christian beliefs, including historical-critical frameworks, comparative reading, source criticism, and other literary methods. Emphasis on developing skills in critical thinking and close reading of early Christian texts as a means of understanding the religion(s) and histories of the earliest Christians. (3H,3C)

3454 (PHIL 3454): PHILOSOPHY OF RELIGION
A consideration of religious belief and its justification with attention to such philosophical issues as the nature and existence of the Judeo-Christian-Muslim God, proofs for the existence of God, the problem of evil, a religious basis for ethics, the nature of faith, and the variety of religious beliefs. (3H,3C)

3494 (HIST 3494) (JUD 3494): THE HOLOCAUST
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovah's Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, personal testimony. (3H,3C)

3504 (HIST 3504): THE AGE OF THE CRUSADES
The origins and development of religious violence examined from an interdisciplinary and cross-cultural perspective; the place of that phenomenon in medieval society. Christianity, Islam, Judaism and their interactions in the medieval world. (3H,3C)

3544 (JUD 3544) (PSCI 3544): THE STATE OF ISRAEL: A POLITICAL HISTORY
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political, economy, etc. Pre: JUD 2134 or PSCI 1024. (3H,3C)

3604: ISLAM AND THE MODERN WORLD
Issues facing the contemporary Islamic world, with a focus on the Islamic resurgence and the concept of Jihad. Muslims re-formulate the Islamic tradition as a response to the pressures of modernity. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4024 (SOC 4024): SOCIOLOGY OF RELIGION
Religion as a social structure as well as an institution; with special attention to the functions of religion for individuals, groups and societies, social organization; and the interplay between religion and other social institutions including economics and polity. Taught alternate years. Pre: SOC 1004. (3H,3C)

4034 (HUM 4034): FUNCTIONS OF POPULAR CULTURE
Popular culture as a humanistic discipline; emphasis on archetypes, formulas, and genres; the function of ideas, images, and icons on the popular imagination. (3H,3C)

4104 (HUM 4104): EXPLORATIONS IN ADVANCED HUMANITIES TOPICS
In-depth study of special interdisciplinary topic. Topics vary but involve a close and extensive study of the interrelationship between cultural ideas and their expressions in several of the following forms: literature,

philosophy, religion, art, music, drama, material culture, and popular culture. May be repeated with different topics, for a maximum of 9 credits. (3H,3C)

4124 (SOC 4124): TOPICS IN CULTURE
Uses sociological, anthropological, as well as artistic and humanist paradigms to analyze culture. Discusses 20th and 21st century cultural trends. Analyzes the implications of social context for cultural artifacts such as art. Topics are variable. Example topics include the cultural construction of race and the culture of the nineteen sixties. Course may be repeated with different course content for up to 6 credits. Junior or Senior standing. Pre: SOC 1004 or SOC 1014 or AFST 1714 or AINS 1104 or RLCL 1004 or RLCL 2004 or WGS 1824. (3H,3C)

4324: TOPICS IN RELIGION AND CULTURE
Selected topics from the religions of the world such as time and the sacred, preliterate religions, women and religion, religion and science, mysticism. May be taken three times for credit with different topics. Pre: 2004. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Sustainable Biomaterials

Head: R. L. Smith
Professors: B.H. Bond, U.K. Buehlmann, R.J. Bush, K.J. Edgar, C.E. Frazier, A.L. Hammett, D.E. Kline, J.R. Loferski, R.L. Smith, P.M. Winistorfer, and A. Zink-Sharp
Associate Professors: D.P. Hindman, H.J. Quesada-Pineda, and M. Roman
Assistant Professors: L. Horvath and Y. Kim
Adjunct Senior Research Scientist: P. A. Araman
Professor Emeritus: W.G. Glasser, M.S. White, and R.L. Youngs

Web: **www.sbio.vt.edu**

Packaging Systems and Design

Learn how sustainable packaging is used to eliminate waste and pollution in the environment, how packaging design enhances products, and how smart materials are used in food and drug packaging to enhance safety and quality.

Sustainable Biomaterials

Apply the STEM disciplines to natural renewable materials to help us develop our sustainable future. Learn how biomaterials can be made and utilized in ways to produce better performing materials with less environmental impact. Study options include sustainable residential structures, creating sustainable society, biomaterials science, and forest products business.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Wood Science and Forest Products Minor and Packaging Science Minor

Minors are offered for students interested in obtaining knowledge and skills in the wood science field to supplement their primary major field of study.

Undergraduate Course Descriptions (SBIO)

1004: EXPLORATIONS IN SUSTAINABLE BIOMATERIALS
Topics and related career paths in Sustainable Biomaterials. Resources promoting academic success, personal improvement, and professional development. Problem solving, inquiry, teamwork, and oral, written, and visual communication applied to sustainable biomaterials issues. (1H,1C)

1234: INTRODUCTION TO WOOD, DESIGN AND CRAFTMANSHIP
Wood as a material. Introduction to laboratory techniques, wood processing, machining and woodworking, moisture interactions, species characteristics, microscopic techniques, measuring material properties, characteristics of forest products industry, career opportunities. (2H,3L,3C)

1984: SPECIAL STUDY
Variable credit course.

2004: COMPUTER-AIDED DESIGN IN PACKAGING
Principles of Computer-Aided Design (CAD) in the packaging industry. Basics of virtual primary package development, computer-aided design of the secondary package, computer-aided optimization of truck loading and palletization. Development of a comprehensive packaging system in a virtual environment. (3H,3C)

2104: PRINCIPLES OF PACKAGING
Packaging systems, materials, and forms and their relationship with the requirements of global societies for the distribution and storage of industrial and consumer products; packaging laws and regulations. (3H,3C)

2114: PACKAGING LAW AND REGULATION
Study of the legal and regulatory issues affecting primary, secondary , and tertiary packaging and packaging systems. Labeling, food and drug, intellectual property, shipping, structural, and environmental laws and regulations affecting packaging design and use. Pre: 2104. (3H,3C)

2124: STRUCTURE AND PROPERTIES OF SUSTAINABLE BIOMATERIALS
Macroscopic and microscopic structure and chemical composition of wood and other biomaterials such as grasses, bamboo, and bagasse. Relationships between anatomical structure and physical/mechanical behavior. Microscopic identification of commercially important biomaterials. Preparation and analysis of microscope slides and scanning electron micrographs. Pre: BIOL 1005, CHEM 1035. (2H,3L,3C)

2384: BEHAVIOR OF SUSTAINABLE BIOMATERIALS
Physical properties of sustainable biomaterials and composite based on structure. Polymer science topics related to sustainable biomaterial composition. Influence of structure on transport properties, response to heat, moisture, electricity, and light. Measurement techniques and reporting for steady-state transport. Pre: CHEM 1035, PHYS 2205. (2H,3L,3C)

2614: INTRODUCTION TO FOREST PRODUCTS MARKETING
Study of marketing systems and methods used by North American primary and secondary forest product industries. Emphasis on wood product industries. Marketing of hardwood lumber, softwood lumber, panels, composites, furniture, and paper products. Role of North American industries and markets in world trade of forest products. (3H,3C)

2784 (FREC 2784): GLOBAL FOREST SUSTAINABILITY

A socio-economic approach to examining the management and use of the world's forests, enhance knowledge of global forest resources and products, and understand the roles and relationships of key stakeholders. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3004: SUSTAINABLE NATURE-BASED ENTERPRISES
Planning for green and sustainability values for profit and non-profit enterprises that produce and market nature-based products and services (e.g., wood products, wildlife, fish, ecotourism). Understanding current green business environments to foster natural resource-based enterprises. (3H,3C)

3005,3006: SUSTAINABLE PACKAGING DESIGN AND INNOVATION
3005: Principles of sustainability, laboratory packaging evaluation including testing procedures, simulation of physical hazards. Professional communications including laboratory reports and oral presentations. Development of comprehensive packaging evaluation plans. Evaluation of existing packaging systems and improving them from the sustainability perspective. 3006: Application of project management to the packing development process. Apply lean management principles to packing design process. Design of sustainable packaging solutions through industry sponsored projects. (2H,3L,3C)

3114: BIODETERIORATION, BIOCONVERSION AND BIOENERGY
Conversion of sustainable biomaterials as part of natural biological, and non-biological, processes and the use of these processes in bioenergy production and carbon cycling. Biological mechanisms and adapted processes for biomaterials conversions including fungal/bacterial/ insect and marine decomposition relative to carbon and nutrient cycling and the production of feedstocks for bioenergy and biomaterials. Deterioration and protection of biomaterials as well as bioconversion for fuels and feedstocks. Protection/preservation of biomaterials including wood, bamboo, rattan, leather, and historic objects is also included. Pre: CHEM 1035, BIOL 1115. (3H,3C)

3124: PAPER AND PAPERBOARD PACKAGING
Paper and paperboard properties and types. Types and performance of flexible paper packaging, sacks, and wraps. Folding carton design, properties of corrugated fiberboard. Corrugated fiberboard container design and performance. Packaging regulations and hazards of the distribution environment. Printing, labeling and automatic identification methods. Pre: 2104. Co: 2004. (2H,3L,3C)

3224: PACKAGING DISTRIBUTION SYSTEMS
Unit load and parcel supply chains. Principles of operation and design of warehouse distribution and fulfillment centers. Principles of operation and design of shipping and distribution systems. The relation between packaging design, pallet design, and unit load design and the operation of industrial consumer goods supply chain. Pre: 2104. (3H,3C)

3234: WOOD IDENTIFICATION PROPERTIES LABORATORY
Physical properties and characteristics of wood. Methods for determining its physical properties. Variation of the properties. Structure, properties, & processing of tropical woods. (3L,1C)

3284: PACKAGING POLYMERS AND PRODUCTION
Introduction to synthetic, natural and sustainable polymer science and engineering as applied to packaging systems. Morphology, rheology, physical and thermal properties, processing methods, and polymerization of traditional, natural and sustainable packaging polymers. Detailed study of relationships among materials, processing, and structural properties through hands-on experience. Both traditional and

advanced industrial mass production technology, and global regulation and environmental impact of packaging articles. Pre: 2104. (2H,2L,3C)

3314: WOOD MECHANICS
Mechanical properties of wood including concepts of stress, strain, Poisson's ratio, orthotropic properties, tension, compression, bending and effects of moisture on mechanical properties. Current issues of wood mechanics in the wood product industry. Standard methods of evaluating important mechanical properties or solid wood, composites and fiber. Pre: 2554, (MATH 1016 or MATH 1025). (3H,3L,4C)

3324: GREEN BUILDING SYSTEMS
Definition of green buildings with specific focus on wood frame single family housing and appropriate green building systems. Site specification, resource efficiency, water efficiency, indoor environmental quality, homeowner education and global impact. Certification in various green building systems. (3H,3C)

3334: SURVEY OF NON-TIMBER FOREST PRODUCTS
In depth study of non-timber forest products of NTFP throughout Appalachia with overseas example - their heritage, uses and markets, economic development opportunities, and sustainable management. Emphasis will be placed on utilization and management issues. Students will gain skills necessary to assess and plan for NTFP business opportunities. (3H,3C)

3434: CHEMISTRY AND CONVERSION OF SUSTAINABLE BIOMATERIALS
Chemical composition of plant matter. Chemistry and biosynthesis of plant components. Cellulosic biofuel technology. Industrial conversion of woody biomass: pulping, bleaching, papermaking. Industrial conversion of cellulose by chemical processes. Pre: CHEM 1036. (3H,3C)

3444: SUSTAINABLE BIOMATERIALS & BIOENERGY
Introduction to the structure and properties of natural composites, biobased polymers, and naturally-derived chemicals for materials and energy applications. Chemistry of biomass deconstruction. Industrial applications of biobased polymers, monomers, and chemicals. Pre: (CHEM 2514 or CHEM 2535), (CHEM 3615 or CHEM 4615). (3H,3C)

3445-3446: ENTREPRENEURIAL WOOD DESIGN AND INNOVATION
Concept to market business project applied to design and innovation of wood products. Product design based on consumer need and sustainable use of natural resources. Writing a business plan including, product innovation, resource sustainability, marketing, strategic planning, production planning, technology utilized, packaging and distribution to final market. (2H,3L,3C)

3454: SOCIETY, SUSTAINABILITY BIOMATERIALS AND ENERGY
Sustainability, raw materials and energy needs of society. Use of sustainable biomaterials to meet society's needs and reduce impact on the environment. Methods to evaluate and certify the sustainability of materials and consumer goods. Carbon sequestration and the use biomass for energy. (3H,3C)

3464: FOREST PRODUCTS BUSINESS SYSTEMS
Business processes of forest/wood product organizations. Business challenges and current business processes and management practices. Organizational methods to study business processes and then plan, execute, and evaluate business performance improvements. The application of techniques to strategic planning, strategy deployment, value stream management, and performance assessment. Business case studies of wood products and forest products related organizations. Junior Standing required. Pre: 2614. (2H,3L,3C)

3534: LUMBER MANUFACTURING AND DRYING
The processing of logs into dry lumber. Principles of log and lumber grading. Design and operation of log sawing and lumber drying systems. Techniques for measuring lumber manufacturing and lumber drying efficiency. The relationship between log quality, sawing, and drying and the quality of the product produced. Pre: 3114. (2H,3L,3C)

3544: SECONDARY WOOD PRODUCTS MANUFACTURING
Secondary wood products manufacturing, including raw materials, rough mill, finish mill, assembly, and finishing. Also covers machinery, wood machining, plant layout, production methods, modern industrial

engineering concepts in secondary manufacturing, and wood treating. Visits to local secondary wood products manufacturing industry. Pre: 3114, 3534. (2H,3L,3C)

3554: SUSTAINABLE BIOMATERIALS ENTERPRISES
Processes and techniques in manufacturing sustainable biomaterial-based products. Contemporary manufacturing, industrial engineering, and business practices in enterprises. Problem solving, operations management, and effective leadership in discrete products manufacturing and sustainable biomaterials production practices. Pre: 1234. (3H,3C)

3634: WOOD PRODUCTS MANUFACTURING
The study of manufacturing processes used in the primary and secondary wood products industry including; lumber; wood moisture relations, drying, durability and the processing of lumber into secondary wood products such as flooring, furniture, and cabinets. Description, selection, and use of the manufacturing equipment used in wood processing. The selection and use of current industrial engineering and business practices applied in wood products manufacturing. How managers solve production and raw material issues. Pre: 2124. (2H,3L,3C)

3954: STUDY ABROAD
Variable credit course.

3964: FIELD STUDY
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

3994: UNDERGRADUATE RESEARCH
Variable credit course.

4004: SENIOR SEMINAR IN FOREST PRODUCTS BUSINESS
Integrated application of principles of management, manufacturing, and marketing as applied to wood-based and related industries. Case analysis, business planning and strategic decision making. Senior standing required. Pre: 3634. (2H,2C)

4024: PACKAGING DESIGN FOR GLOBAL DISTRIBUTION
Understanding, identification, and measurement of hazards in physical distribution including sea, air, and various land transportation, storage methods, and use of sanitation methods. Knowledge, analysis, and selection of sustainable protective packaging materials. Design and analysis of packaging protection against such hazards as shock, vibration compression, and climate. Laboratory testing of shock, vibration and compression, and performance testing of packaging and components. Packaging design in global context. Pre: 3224. (2H,3L,3C)

4054: PACKAGING SYSTEMS DESIGN PRACTICUM
Integrated application of principles of packaging design and manufacturing. Design briefs, package development process, structural requirements, manufacturing and distribution plans, target markets and positioning. Senior Standing required. (2H,3L,3C)

4154: COMPUTER APPLICATION SYSTEMS IN FOREST PRODUCTS
Computer control systems with applications in the forest products industry. Survey of systems for gathering, inputting, conditioning, and managing information. Hardware and software systems for computer control applications. Use of information technologies to integrate control subject to raw material, quality, and market fluctuations. Forest products case studies in data acquisition, data analysis, database management production planning, process control, inventory control, and systems specification. Junior standing is required. (2H,3L,3C)

4214: FOOD AND HEALTH CARE PACKAGING
Designed for both current and advanced food and health care packaging. Covering the types of materials and their properties, fabrication, functions, distribution and packaging life cycle for food and health care packaging systems and design. Reviewing recent trends in food and health care packaging systems;

sustainable food packaging, medical device packaging, aseptic packaging, package/product interactions, smart active packaging, handling of packages, and modified atmospheric packaging. Exploration to global food and health care packaging standards and compliance, safety issues, and environmental considerations. Pre: 3124, 3284. (2H,2L,3C)

4224: WOOD PALLET, CONTAINER, AND UNIT LOAD DESIGN
Wood pallet design and performance. The design of wood containers and crates. Design and performance of unit loads. Design and performance of unit load equipment, i.e., conveyors, racking systems, automatic guided vehicles, fork trucks. Principles of unit load design. Mechanical interactions between pallets, packaging, and unit load handling equipment. Unit load stabilization techniques, i.e., strapping, stretch wrapping. International phytosanitation regulations of solid wood packaging; principles of dunnage, blocking and bracing. Pre: 4024, 3224. (2H,3L,3C)

4314 (CEM 4314) (CNST 4314): DESIGN OF WOOD STRUCTURES
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls. Pre: 3314 or CEE 3404. (3H,3C)

4384: BIOREFINERY SCIENCE
Biomass utilization as an industrial resource. Biorefinery processes such as cultivation, harvesting, separation, and biomass processing into industrial products compared to the petroleum refinery. Routes to the production of bioenergy, biochemicals, and biofuels. Resource availability and energy consumption, environmental implications of a biorefinery system, public policy influence on development of biorefineries. Pre: 3434. (3H,3C)

4424 (CHEM 4424): POLYSACCHARIDE CHEMISTRY
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials. Pre: CHEM 2536 or CHEM 2566. (3H,3C)

4444: PLANT POLYMERS & BIOCOMPOSITES
Evolution of vascular plants and plant polymers in the context of materials science and biocomposites. Anatomical, physical, and mechanical properties of wood, bamboo, and hemp. Polymer science, plant polymer science, surface chemistry, and adhesion science for biocomposites made from wood, bamboo, and hemp. Contemporary adhesives and resins for biocomposites manufacture. Pre: CHEM 2514 or CHEM 2536. (3H,3C)

4514: WOOD PRODUCTS INDUSTRY STUDIES
Field studies of the processing systems and product manufacturing procedures of various wood products industries. Pre: 3114. (3L,1C)

4624: WOOD INDUSTRY PRODUCTION OPERATIONS MANAGEMENT
Study of the operation of wood products organizations. Problems facing these organizations and current management practices used to address these problems. Investigation of the design and implementation of wood industry management improvement efforts. How organizations and groups design, implement, and evaluate improvements efforts. The application of techniques to production planning, financial management, inventory management, quality, human resources management, technology, performance measures, and assessment. Includes case studies of wood products manufacturing companies. Pre: 3544. (2H,3L,3C)

4634: FOREST PRODUCTS BUSINESS MANAGEMENT
This course will describe the allocation of resources within a forest products business. Students will determine how to allocate natural, human and financial resources to maximize profitability within the organization. How allocation decisions affect all stakeholders of the organization will be demonstrated and this allocation’s impact upon strategic planning will be discussed. The course will also show the

impact of the external business environment on management decisions. Pre: 1234, 2614, 3114. (3H,3C)

4714: WOOD PERFORMANCE IN CONSTRUCTION
Interactions of building code requirements, wood materials and building construction with special emphasis on relative merit of wood and wood-based composites versus non-wood alternatives. Construction details that lead to long-term performance such as controlling moisture infiltration, preservatives, and proper selection of materials, preservation of historic wood buildings, effectiveness and efficiency of wood building systems. Pre: 4315. (3H,3C)

4715,4716: WOOD HOUSE
4715: Principles of manufacturing sustainable biomaterials into primary and secondary products used in construction of wood buildings, houses and in manufacture of wood consumer goods used in housing. Raw material estimation, lumber production, veneering, composite and paper products. 4716: The use of manufactured wood materials in the construction of wood buildings. Interactions of building code requirements, wood and wood composite materials as sustainable biomaterial components within houses. Durability, deterioration, controlling moisture infiltration, preservatives and proper selection of materials, historic wood buildings, effectiveness and efficiency of wood building systems. Pre: 3314. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Sociology

Interim Chair: James Hawdon
Professors: O. Agozino, D. Brunsma, T. M. Calasanti, J. Hawdon, M. Hughes, N. King, J. Ryan, and W. Reed
Associate Professors: S. Bell, J. Bondy, S. R. Cook, K. Harrison, C. Labuski, S. Ovink, A. Peguero, P. Seniors, A. Vogt Yuan, D. W. Wimberley, B. Zare, and H. Zhu
Associate Collegiate Professor: S. Samanta
Assistant Professors: A. Baldwin, L. Brown, N. Copeland, T. Dearden, K. Parti, A. Reichelmann, T. Rocha Beardall, M. Roos, D. Sedgwick
Assistant Professor of Practice: C. Hey
Adjunct Professors: R. Blieszner, D. Breslau, G. L. Downey, N. McGehee
Senior Instructor and Assistant Provost for Diversity & Inclusion: E.T. Graves
Instructor: H. Williams
Career Advisor: D. Sedgwick
Academic Advisor: B. Husser and A. Karnes
Distinguished Professor Emeritus: W. E. Snizek

Emeritus Professors: C. Bailey, C. Burger, J. N. Edwards, B. R. Hertel, L. Gillman, J. Kiecolt, J. W. Michaels, and D. R. Shoemaker

Web: **www.sociology.vt.edu**

Overview

The Department of Sociology offers a B.S., M.S., and Ph.D. Sociology is the home to two majors, sociology and criminology, and to programs in Africana Studies (AFST), American Indian Studies (AINS), Women's and Gender Studies (WGS), the Center for Peace Studies and Violence Prevention (CPSVP) and the Center for Race & Social Policy Research (RSP). Courses are open to students in all colleges of the university.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Sociology Major

In addition to fulfilling the requirements of the General Education (Curriculum for Liberal Education for students graduating in 2021 or before and Pathways for students graduating in 2022 and beyond) sociology majors must complete 43 hours in sociology, including: 22 hours of sociology core courses and 18 hours of sociology electives, with no more than six hours at the 1000-2000 level and at least nine hours at the 4000 level and three hours in Africana Studies, American Indian Studies, or Women's and Gender Studies at the 3000 or 4000 level.

Sociology majors may select options in Africana Studies, American Indian Studies, Research Methods, Social Inequality, and Women's and Gender Studies. Each option has it own course requirements. Please request additional information from the department office.

Criminology Major

In addition to fulfilling the requirements of the General Education (Curriculum for Liberal Education for students graduating in 2021or before, and Pathways for students graduating in 2022 and beyond) criminology majors must complete 43 hours in criminology, including: 22 hours of sociology core courses, 9 hours of required criminology courses, and 12 hours of elective criminology courses.

Minors

Minors in sociology must complete 18 hours in sociology including Introduction to Sociology (SOC 1004). No more than nine hours at the 1000-2000 level will count toward a minor. A minimum GPA of 2.0 for courses in the minor is required. Sociology offers additional minors in Africana Studies, American Indian Studies, Diversity and Community Engagement, Gender, Science and Technology, Peace Studies and Violence Prevention, and Women's and Gender Studies. See the listing of the programs below for further information.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways) (see "**Academics**") and toward the degree in Sociology.

Satisfactory progress requirements toward the B.S. in Sociology can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Africana Studies Program

Director: Ellington Graves, Assistant Provost for Diversity & Inclusioin
Professors: O. Agozino and W. Reed
Gloria Smith Endowed Professor: K. Harrison (Africana Studies/Sociology)
Associate Professors: K. Harrison (Africana Studies/Sociology), P. Polanah, and P. Seniors
Assistant Professor: Andrea Baldwin
Affiliated Faculty: R. Briggs (Political Science), N. Giovanni (English), B. Faulkner (Political Science), A. Few (Human Development), V. Fowler (English), C. Gitre (History), M. Heaton (History), M. Herndon (Summer and Winter Programs), S. Johnson (Religion and Culture), R. Jones (Psychology), L. Roy (English), T. Sato (School of Education), B. Shadle (History), and P. Wallenstein (History).

Africana Studies is an interdisciplinary field of study that uses concepts and methodologies of the Social Sciences and the Humanities, centering on the study of peoples of African descent. The program cooperates with faculty from across the university, whose teaching and research is concerned with Africa and the African diaspora. Africana Studies engages with other programs and organizations in community awareness activities that celebrate the richness and diversity of African diasporic cultures and traditions.

An Africana Studies minor is open to all students who are interested in learning about the experiences of Africans and people of African descent.

American Indian Studies: A Holistic Approach

Director: Samuel R. Cook
Associate Professor: S. Cook
Assistant Professor: N. Copeland and Theresa Rocha Beardall
Assistant Professor of Practice: Mae Hey

A program in the Department of Sociology, we offer several courses and a minor in American Indian Studies.

We believe that any successful American Indian Studies program must do more than simply educate a general student body on American Indian cultures and issues in a sensitive way. We believe that our curricula must exist in conjunction with all university programs pertinent to American Indians, and must depend on the impetus of indigenous peoples working within and beyond the university.

In keeping with Virginia Tech's status and mission as a land grant institution, we strive to serve our indigenous constituency, both as educators and as partners. Accordingly, our program serves as a vital conduit for university-tribal relations, the recruitment and retention of American Indian students and faculty, and Service-Learning initiatives in indigenous communities. Although our program has a regional

focus, we offer a wide spectrum of courses--ranging from American Indian Literatures, American Indian Spirituality, and American Indian Arts, to native Peoples of the Southeast, American Indians in Film, and Global indigenous Rights--reflecting the impressive and diverse expertise of our faculty.

In short, we embrace a holistic, collaborative approach to American Indian Studies in which university faculty and students develop and maintain meaningful partnerships. Accordingly, we maintain a tribal advisory board consisting of elders and leaders from all of Virginia's eight Indian Nations. We regard these representatives, and ultimately, all indigenous peoples as our colleagues.

Women's and Gender Studies Program

Director: Sharon P. Johnson
Professors: N. M. King
Associate Professors: J. Bondy, C. Labuski, and B. Zare
Collegiate Associate Professor: S. Samanta
Assistant Professors: A. Baldwin
Presidential PATHWAYS Teaching Doctoral Fellow: S. M. Cassinell

Affiliated Faculty
Professors: O. Agozino (Africana Studies); R. Blieszner (Human Development); T. Calasanti (Sociology); E. Creamer (Educational Leadership and Policy Studies); K. DePauw (Graduate School, Sociology, Human Nutrition, Foods, and Exercise); G. Downey (Science and Technology in Society); T. Ewing (History); J. Folkart (MCLL-Spanish); V. Fowler (English); P. Lane (STS/Director AdvanceVT); I. Luciak (Political Science); M. Paretti (Engineering Education); E. Plummer (Office of Provost); K. Powell (English); J. Rothschild (Government and International Affairs); L. Roy (English); B. Shadle (History); K. Singh (Education); D. Stoudt (CLAHS); V. Venkatesh (MCLL-Spanish); J. Watson (MCLL--French)
Associate Professors: E. Bauer (MCLL-German); S. Bell (Sociology); S. Carter-Tod (English); G. Chandler (English); W. Dunaway (Government and International Affairs); J. Dunsmore (Psychology); April Few-Demo (Human Development); S. Fowler (Graduate Education Development Initiative, English); S. Halfon (Science & Technology Studies); L. Jenson (Associate Professor and Chair CPAP, School of Pub Internat Affairs); María del Carmen Caña Jiménez (MCLL-Spanish); S. Johnson (MCLL-French); C. Kaestle (Human Development); S. Knapp (English); E. Meitner (English) M. Mollin (History); S. Fang Ng (English); P. Olson (STS); S. Ovink (Sociology); E. Satterwhite (Religion & Culture); R. Scott (Religion & Culture); R. Shingles (Political Science); N. Sinno (MCLL-Arabic); C. Giménez-Smith (English); D. Tatar (Computer Science); G. Tilley-Lubbs (ESL & Multicultural Education); A. Walker (Linguistics)
Assistant Professors: K Carmichael (Linguistics); C. Daggett (Political Science); J. Sano-Franchini (English); E. Grafsky (Human Development); R. Hester (STS); E. Jamison (Management); A. Reed (English); A. Reeves (Political Science); A. Reichelmann (Sociology); A. Sharma (Industrial Design); N. Zhange (MCLL
Professional Faculty: E. Chancey (Religion & Culture); M. E. Christie (Women in International Development); M. C. Deramo (Director Diversity Ed and Initiative); A. Lomascolo (Co-Director, Women's Center); K. Mey (Women's Center); L. Pendleton (Electrical and Computer Engineering); E. Plummer (Associate Vice Provost for Academic Administration); K. Precoda (Theatre & Cinema); C. Smith (Co-Director, Women's Center); A. Sowisdral (Women's Center); L. Wheeler (Psychology)

The field of Women's and Gender Studies (WGS) transforms traditional disciplines through new methods and theories generated by feminist scholarship. The Women's and Gender Studies Program is housed in the Department of Sociology and includes teaching faculty and affiliates from across the entire university. WGS affiliated faculty contribute to the program through their research, student advising, participation in governance, and teaching. Women's and Gender Studies 1824 is a pathways course. Our program also offers courses for all students in the university, including four in Area 2 of the Curriculum for Liberal Education (WGS 1824, WGS 2224, WGS 2244, and WGS 2254), one in Area 3 (WGS 2264), and one in Area 7 (WGS 3214). Students interested in WGS may select from two minors, Women's and Gender Studies, and Gender, Science, and Technology. The degree option and minors are interdisciplinary, cross-cultural programs of study in which students cultivate an understanding of the complex ways that gender is defined and contested in social structures, history, culture, and technology. They offer students new ways of thinking about how gender, race/ethnicity, class, and sexuality shape social institutions and

cultural beliefs as well as personal experiences and perceptions. Central to the mission of the Women's and Gender Studies Program is the empowerment of a diverse population of women within local, regional, national, and global contexts.

Students interested in learning more about the Women's & Gender Studies program should contact the program director, Sharon Johnson at **spjohnso@vt.edu**

Center For Peace Studies and Violence Prevention

Director: James Hawdon

The Center for Peace Studies and Violence Prevention is a student-center, multi-disciplinary undertaking to promote research, education and outreach in the area of peace studies and violence prevention. Since its inception in 2008, the Center has adopted three thematic areas:

- The prevention of violence
- Peace studies
- The development of new leaders for this century

The Center is a hub for research and pedagogy on peace studies and violence prevention. Our multidisciplinary approach allows students, faculty, and a variety of off-campus constituents to address peace building and violence prevention in a holistic manner.

The Center for Peace Studies offers a minor in Peace Studies. The minor is designed to provide students with a broad perspective on violence prevention and peace building. Students minoring in Peace Studies will be required to take two core courses, Peace and Violence as Critical Incidents (PSVP 2044) and Global Society, Violence and the Prospects for Peace (PSVP 4104). In addition, students will select four elective courses from a variety of courses that focus on either "local" issues of violence prevention and peace building or "global" issues of violence prevention and peace building.

Center for Race & Social Policy

Director: Wornie Reed

The Center for Race and Social Policy (RSP), presently a College Center, was formed in April 2001 as a University Center to fulfill two primary goals: (1) to conduct and disseminate original research in the area of public policy with a direct emphasis on race and ethnicity; and (2) to prepare promising graduate students to think and speak critically, plan quality research, and contribute to public-policy discussions related to race and ethnicity.

The Center promotes a broad and inclusive concept of race and ethnicity, which includes African Americans, American Indians, Asian Americans, European Americans, Latinos, and bi-racial and multi-racial identities. RSP research projects involve the development and evaluation of public policy across different racial and ethnic contexts and within myriad public policy venues, including welfare, employment, education, and health as well as community outreach.

Undergraduate Course Descriptions (AFST)

1714: INTRODUCTION TO AFRICAN AMERICAN STUDIES
Introduction to the interdisciplinary field of African American Studies. Consideration of key dimensions of African American experiences, including institutional contexts for African American cultural expression and responses to oppression. History of the field, exploration of subfields, and consideration of research methods. Emphasis on the interplay of African American Studies scholarship and activism. (3H,3C)

1814: INTRODUCTION TO AFRICAN STUDIES
Introduction to the interdisciplinary study of Africa and Africa's place in the world. Consideration of history, politics, economics, arts, and culture of African societies. Exploration of representations and treatments of

Africa in global context. Discussion of scholar-activism in the study of Africa. (3H,3C)

2144 (RLCL 2144): AFRICAN RELIGIONS
The role of religious (or belief) systems in African society, especially the three predominantly religious traditions in Africa: the so-called African traditional religions, Islam, & Christianity; the universe of religious systems and religious experiences and processes of Africa, in particular Sub-Saharan Africa; critical examination of the mythic stature of Africa's "religions" within Western cultural (and scholarly) world views and institutions. (3H,3C)

2204 (RLCL 2204) (WGS 2204): RACE AND GENDER IN RELIGION AND CULTURE
Influence of race and gender on religion and culture. Overview of approaches to categories of diversity, particularly race and gender, in religious and cultural traditions. Utilization of humanistic and social scientific approaches to investigate geographically variable historical and/or contemporary case studies. (3H,3C)

2264 (SOC 2264) (WGS 2264): RACE, CLASS, GENDER, AND SEXUALITIES
Focuses on how race, class, gender, and sexualities form interlocking systems of privilege and oppression at individual and institutional levels. Emphasizes race, class, gender, and sexualities as changing social constructions and interactive systems that shape social institutions and organizations, meanings, and identities. Pre: WGS 1824. (3H,3C)

2275,2276 (HIST 2275, 2276): AFRICAN-AMERICAN HISTORY
2275: African continent through Civil War. Examines trajectory of slavery as well as its global impacts and legacy, the development of racial thought, slave resistance and rebellions, the fight for Emancipation, and African American contributions to culture, economics and society of United States. 2276: Reconstruction through present. Examines impact and legacy of Reconstruction, the fight against Jim Crow segregation, and the social, cultural, political and economic contributions of African Americans in the nineteenth and twentieth century United States. Exploration of the global implications of race relations in the United States. (3H,3C)

2354: THE CIVIL RIGHTS MOVEMENT
Examines the Civil Rights Movement in the U.S. Both non-violent and violent resistance will be examined, as well as strategies used in organizing mass boycotts, sit-ins, and marches. Special attention will be paid to how the movement shaped civil rights legislation on the federal level. The course also examines how the Movement influenced student protest on college campuses. (3H,3C)

2454 (SOC 2454): RACE AND RACISM
Examines theories of race and racism specifically as they relate to African Americans. We will explain conservative, neo-conservative, liberal, and progressive ideologies concerning race in past and recent United States contexts and how such theories emerged and continue to emerge in recent times. Though the majority of the course focuses on race and racism within the U.S., comparative analyses will be made with Brazil and South Africa. (3H,3C)

2644 (ENGL 2644): INTRODUCTION TO AFRICAN-AMERICAN LITERATURE
An introduction to the principal themes, genres, and historical contexts of African-American literature. Formal elements of both the vernacular and written traditions. Impact of historical and social contexts. Ethical questions raised in the literature. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

2734: THE BLACK WOMAN IN THE U.S.
The emerging womanist perspective of "interstructured oppression," (i.e., the simultaneous effects of racism, sexism, and classism) as relevant to the contributions of Black women in the U.S.; views of Black women from African backgrounds, the Atlantic slave trade, and the progressive rise of womanist/feminist liberation movements in Black culture; contributions of Black women in the U.S. and globally. (3H,3C)

2754: SPORTS AND THE AFRO-AMERICAN EXPERIENCE
Sports as a paradigm of the African-American experience. The forms of racism and the periodic significant social advances of the African-American community in the U.S. will be examined from the vantage point of African-American sports. Attention will also be paid to the continuing impact of sports on

African-American culture. Sports heroes, successful teams and annual sporting events will be noted and analyzed. (3H,3C)

2774: BLACK AESTHETICS
A definition of those qualities of black American arts which distinguish it from traditional U.S. arts through an analysis of theme, form, and technique as they appear in a representative sample of works by black creative artists. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3174: AFRICAN AMERICAN MEN IN UNITED STATES HISTORY
Chronological and thematic examination of significant historical moments in black men's lives. Examination of the social, cultural, and political forces contributing to a uniquely African American male experience in the United States. Survey of events in America's collective past such as wars, depressions, and protest movements. (3H,3C)

3444 (CINE 3444): AFRICAN AMERICAN IMAGES IN FILM
Explores race and representations of African American images in film, from multiple disciplinary perspectives. Focuses on the social, political, economic, and historical milieu in which black film emerged and evolved. Examines gender issues in filmmaking. Reviews different genres, including race films, colorblind representations, and black exploitation films, and the appropriation of black representation and black images in film in the United States and elsewhere. Includes methods of film analysis, such as historical, master narrative structure, and archival research. Pre: 1714. (3H,3C)

3454: AFRICAN AMERICAN LEADERSHIP FOR SOCIAL CHANGE
This course will utilize the three major paradigmatic assumptions in Black Studies (centeredness, critical analysis, and empowerment) to examine historical and contemporary African American leadership concepts and styles and their impact on social change. (3H,3C)

3864 (HIST 3864) (IS 3864): DEVELOPMENT AND HUMANITARIANISM IN AFRICA
Examines the history of western development and humanitarian projects in Africa, considering western and African perspectives in the nineteenth and twentieth centuries. Discussion of slavery and abolition, the civilizing mission, modernization and development theory, the impact of humanitarian projects, and international volunteerism. Provides a foundation for students interested in international service learning or careers with NGOs or international aid agencies. No prior knowledge of African history required. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4354: TOPICS IN AFRICANA STUDIES
A variable topics course examining the lives and circumstances of people of African descent. Students may repeat the course with a different topic for up to 6 credits. Pre: Junior Standing. (3H,3C)

4704: HISTORY OF AFRICAN-AMERICAN THEATRE
An in-depth study of Black Theatre in America. It will explore the history and development of Black Theatre - both commercial and non-commercial. The course will also stimulate critical thinking pertaining to racial issues, differences in aesthetics and cultures. Pre: 1714. (3H,3C)

4754: INTERNSHIP
Variable credit course.

4774: BLACKS IN THE PERFORMING ARTS
An examination of the performing arts as a paradigm of the African-American experience. Forms of U.S. racism and the periodic significant social advances of the U.S.'s African-American community will be

examined in this course from the vantage points of blacks in theatre, film, dance, and music. Emphasis will be placed on the continuing impact of performing arts on African-American culture. Performers, heroes, historical works and performing arts events will be analyzed. Pre: 1714. (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (AINS)

1104: INTRODUCTION TO AMERICAN INDIAN STUDIES
Introduction to the historical richness and complexity of American Indian societies. Examination of American Indian identities, worldviews, past and present sustainability practices, experiences with and resistance to colonial domination and policies, and cultural interchanges with non-Indians. (3H,3C)

2104 (HUM 2104): ORAL TRADITIONS AND CULTURE
Examination of the world's great oral traditions, both ancient and contemporary. Emphasis on performance contexts, relationships among multicultural traditions, including American Indian oral traditions, and the relationships among orality, literacy, technology, media, and culture. (3H,3C)

2414 (ALCE 2414): IDENTITY AND INCLUSION IN AGRICULTURAL AND LIFE SCIENCES
Examines histories of persons representing different social identities, statuses, space, place, and traditions in agricultural and life sciences. Explores how differences influence experiences individuals may have in agricultural and life sciences. Apply ethical reasoning practices to recognize and addresses critical issues surrounding inclusion of diverse populations within agricultural and life sciences education and leadership. Pre: ENGL 1106. (3H,3C)

2804 (ENGL 2804): CONTEMPORARY NATIVE AMERICAN LITERATURES
This course offers a sampling of fiction, poetry, and non-fiction by the most influential American Indian writers since 1970, authors such as Momaday, Silko, Deloria, Welch, Harjo, and Alexie. Students will also learn about those aspects of cosmology and storytelling traditionally shared by all American Indian Nations, as well as about those aspects specific to the individual tribal traditions from which the authors and their characters come. Pre: ENGL 1106 or ENGL H1204 or COMM 1016. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

3304 (ENGL 3304): THE LANGUAGES OF NATIVE AMERICA
Study of the structures of the native languages of the Americas; their interrelationships; their use in individual speech communities; contact with other languages; the interrelationships of linguistic structure, culture, and thought; their future survival. Pre: ENGL 1106 or ENGL H1204 or COMM 1016. (3H,3C)

3684 (PSCI 3684): INDIGENOUS PEOPLES AND WORLD POLITICS
A survey of the historical and contemporary struggles of indigenous peoples throughout the world.

Examines the dynamics of colonialism (internal and external), identity construction, gender, cultural integrity, and the ongoing global indigenous rights discourse. In addition to covering broad global processes/theoretical approaches, comparative case studies of particular indigenous groups, such as the Maasai (Kenya, Tanzania) and Mayans (Mexico, Guatemala, Belize), are used to highlight the global, regional, and intra-community diversity among contemporary indigenous peoples. (3H,3C)

4004: TOPICS IN AMERICAN INDIAN STUDIES
A variable topics course in which students will engage an interdisciplinary methodology to pursue a critical and in-depth examination of various topics concerning and pertinent to American indigenous peoples. This course is repeatable for up to 6 hours credit with different topics. Must meet prerequisite or have permission of the instructor. Pre: 1104. (3H,3C)

4754: INTERNSHIP
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (CRIM)

2754: INTERNSHIP
Variable credit course.

2964: FIELD WORK/PRACTICUM
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3414: CRIMINOLOGY
Principles of criminology and contemporary theories of criminal behavior, focusing on the extent and distribution of crime in the United States. Pre: SOC 1004, SOC 2404. (3H,3C)

3434: SYSTEMS OF JUSTICE
Analyzes the systems of justice in the United States, from a sociological perspective. Focuses on law enforcement, courts, and corrections. Evaluates the effectiveness of social policies related to systems of justice. Explores the structural, community, and individual level factors that influence different stages of justice systems. Pre: SOC 2404, CRIM 3414. (3H,3C)

3474: WOMEN AND CRIME
Focuses on women as victims and perpetrators of crime, with particular attention to race and class. Analyzes how social, cultural, and economic factors influence victimization and participation in crime. Includes adolescent girls' involvement with crime, including juvenile gangs. Evaluates theoretical explanations of why women commit crime. Examines women's experiences with the criminal justice system. Pre: 3414 or SOC 3414. (3H,3C)

4424: JUVENILE DELINQUENCY

Examination of juvenile delinquency. Includes methods of data collection and the extent and distribution of delinquency. Detailed coverage of theories of delinquent behavior. Examines the juvenile justice system and treatment and prevention of delinquency. Utilizes current empirical research on delinquency in the U.S. and internationally. Pre: SOC 3414 or CRIM 3414. (3H,3C)

4454: TOPICS IN CRIMINOLOGY
A variable topics course in criminology. In-depth examination of topics such as capital punishment, women and criminology, racial profiling, terrorism, white collar crime, law enforcement, international gangs, political crime, the prison system, cybercrime, and rape. May be repeated 2 times with different content for a maximum of 9 credits. Junior standing. Pre: (3414 or SOC 3414), SOC 3104. (3H,3C)

4474: CYBER CRIMINOLOGY
Empirical patterns and consequences of cybercrimes. Emphasis on applying criminological theories of crime and victimization to cyberspace. Cybercrime prevention strategies and tactics. Examination of ethical issues of privacy, security, and social control. Pre: Junior standing. Pre: 3414. (3H,3C)

4754: INTERNSHIP
Variable credit course.

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (PSVP)

2044: PEACE AND VIOLENCE
Introduces major theories of peace and violence. Explores contemporary patterns and root causes of interpersonal, institutional, and structural violence. Particular attention to conflict management, prevention, strategies, and promotion of peace at the local, national, and global levels. (3H,3C)

2984: SPECIAL STUDY
Variable credit course. 4104: GLOBAL SOCIETY, VIOLENCE AND THE PROSPECTS FOR PEACE
Examines major theories in the interdisciplinary field of peace studies. Includes current, historical, and global causes, patterns and types of conflict, and methods of conflict resolution. Particular attention given to the philosophical and sociological discussions of the causes of violence and the possibilities for peace. Pre: 2044 or SOC 2044. (3H,3C)

4444 (SOC 4444): SCHOOLS, VIOLENCE, AND JUSTICE
Focuses on the nature, extent, causes, and consequences of widely recognized forms of violence within schools, such as bullying, fighting, sexual assaults, harassment, dating violence, and shootings. Examines the effectiveness of violence prevention programs. Includes sociological theories of violence within schools. Explores the social debate over balancing the collective public safety obligations of schools with individual students' rights/responsibilities. Pre: SOC 3414 or CRIM 3414. (3H,3C)

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (SOC)

1004: INTRODUCTORY SOCIOLOGY
Principles and basic concepts of human interaction and social organization. Basic theories and research methods, socialization, deviance, social institutions, population dynamics, social change, and social inequality by social class, race/ethnicity, gender, and sexual orientation. (3H,3C)

1014: INTRODUCTION TO SOCIAL ANTHROPOLOGY
Introduction to basic concepts including culture and ritual, research methods especially ethnography, and theory in social anthropology for understanding human behavior. Provides a survey of anthropological approaches to language, economics, kinship, religion, identity, gender, race, politics, social organizations, and globalization that compares western and non-western cultures. (3H,3C)

1024: FIRST YEAR EXPERIENCE IN SOCIOLOGY
Develop an identity as a sociologist and foster a sense of community with first year and transfer students in the department. Acquire research skills and an awareness of university resources that enhance academic success. Explore theories used and topics examined by sociologists and participate in sociological research. Identify careers and internship opportunities in sociology. (1H,1C)

1XXX3: GEN ED REASONING SOCIAL SCI
(3H,3C)

2004: SOCIAL PROBLEMS
Examines the nature, extent, and causes of social problems in the United States and around the globe from multiple perspectives. Emphasizes the role of social structural forces including conflicting economic, racial, ethnic, national, and gender interests in the creation and perpetuation of social problems. Discussion of poverty, work, health care, drugs, terrorism, human rights, and social change. (3H,3C)

2014: SOCIOLOGY OF INTIMATE RELATIONSHIPS
An introduction to concepts, theories, methods, and major research findings in the sociology of intimate relationships. A description and analysis of research findings on the development, operation, and dissolution of intimate relationships, including how sociocultural and economic changes have shaped intimate relationships over time. Emphasis on the United States, including issues of diversity and inequalities in intimate relationships. (3H,3C)

2024: SOCIOLOGY OF RACE AND ETHNICITY
Social construction of race and ethnicity. Relations among ethnic and racial groups. Immigration and patterns of racial and ethnic integration. Social structures and processes that perpetuate racial and ethnic stratification. Consideration of economic, social, political, and health challenges facing racial/ethnic minority groups in U.S. society. Core Curriculum approved for CLE Area 2 only when taken only in combination with AFST 1714. (3H,3C)

2034: DIVERSITY AND COMMUNITY ENGAGEMENT
Examination of patterns, meanings, and challenges of diversity and inclusion to improve social interactions and community engagement within a global society. Focus on diverse identities, social justice, power, and privilege, applying social science theories and concepts, to facilitate intercultural awareness. Community engagement projects employ research methods to connect course materials and service to community. (3H,3C)

2054 (RLCL 2054): ETHNOGRAPHY: STUDYING CULTURE
Introduction to the methodological tools used by anthropologists and other social scientists to study culture. Engagement with the development of, and debates about, ethnographic methods, as well as their application to case studies. Focus on sample ethnographic accounts of peoples throughout the world, as well as research techniques applicable to many different cultural environments. (3H,3C)

2104 (HD 2104): QUANTITATIVE APPROACHES TO COMMUNITY RESEARCH
Computational methods and ethical issues in the collection, transformation, consumption, and use of quantitative data in the design and evaluation of community programs. Consideration of effective data visualization and communication of findings. Emphasis on evaluating the reliability and accuracy of data used to frame decisions about community-related policies and service-oriented programs. (3H,3C)

2264 (AFST 2264) (WGS 2264): RACE, CLASS, GENDER, AND SEXUALITIES
Focuses on how race, class, gender, and sexualities form interlocking systems of privilege and oppression at individual and institutional levels. Emphasizes race, class, gender, and sexualities as changing social constructions and interactive systems that shape social institutions and organizations, meanings, and identities. Pre: WGS 1824. (3H,3C)

2304: INDIVIDUAL IN SOCIETY
Foundation in social psychological principles of sociology including the development of the self through social interaction and intergroup processes. Factors affecting self-perceptions, ways of thinking, attitudes, emotions, behavior, and psychological well-being in social contexts. (3H,3C)

2404: DEVIANT BEHAVIOR
Examines behaviors considered deviant in the United States. Explores major types of deviant behavior, such as corporate crimes, extremist groups, sexual deviance, violence, suicide, alcoholism and other drug addictions, and cyber deviance. Includes sociological theories that explain them. (3H,3C)

2454 (AFST 2454): RACE AND RACISM
Examines theories of race and racism specifically as they relate to African Americans. We will explain conservative, neo-conservative, liberal, and progressive ideologies concerning race in past and recent United States contexts and how such theories emerged and continue to emerge in recent times. Though the majority of the course focuses on race and racism within the U.S comparative analyses will be made with Brazil and South Africa. (3H,3C)

2514 (RLCL 2514): ASIAN AMERICAN EXPERIENCE
Interdisciplinary overview of the diverse Asian American experience, incorporating non-Eurocentric perspectives on the Asian immigrant experience and dialogue between Asian American and non-Asian American students. Examination of different historical tracks of various Asian ethnicities, experience of racism, discrimination, cultural adaptation and conflict, and economic survival and success. Gender, age, religious affiliation, family values and inter- generational differences among Asian Americans. The complexity of minority status and the stereotype of "model minority." Activism, political participation, leadership and the meaning of citizenship among Asian Americans. Representations of Asian Americans in the arts and media. (3H,3C)

2604 (HIST 2604) (STS 2604): INTRODUCTION TO DATA IN SOCIAL CONTEXT
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: SOCIAL INEQUALITY

Class, status, and power in society. Theories and empirical research findings on vertical and horizontal stratification in society. Class differences in behavior, values, and avenues and extent of social mobility. Cross cultural comparisons. Pre: 1004. (3H,3C)

3014: GENDER RELATIONS
Focus on the social construction of gender relations. Examines how gender relations vary cross-culturally, historically, and for different categories of men and women. Explores the causes and consequences of inequality and privilege. Attention paid to the ways race, ethnicity, class, age, and sexualities shape and are shaped by gender and the relationship of gender to social institutions. Pre: 1004. (3H,3C)

3104: SOCIOLOGICAL THEORY
Focus on the development and contemporary state of sociological theory. Primary concern is with those theorists who have had significant impact on our thinking about the relationships among man, society, and nature. Pre: 1004. (3H,3C)

3144 (ENGL 3144) (RLCL 3144): LANGUAGE AND ETHNICITY IN THE UNITED STATES
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

3204: SOCIAL RESEARCH METHODS
Techniques of data collection and analysis employed in the social sciences with emphasis on survey research methods including questionnaire construction, sampling, and analysis of both self-collected and national data; logic behind application of these techniques. Pre: 1004. (4H,4C)

3304: COLLECTIVE ACTION
How people organize to influence institutional arrangements in society. Panic behavior, riots, protest movements, strikes, coalitions, and revolutions. Theories and issues related to collective action. Pre: 1004. (3H,3C)

3314: SOCIAL MOVEMENTS
The study of collective attempts to address social injustices and implement other social change in and across societies. Explores sociological and interdisciplinary conceptions of social movements and their relationships to society. Social movement emergence, development, engagement with opponents and authorities, and impact, as shaped by opportunity structures, mobilizing structures and processes, framing, collective identity, strategy and tactics, and other factors. How social movements oppose or promote inequality, oppression, or violence in the U.S. or elsewhere, at the local, national, and transnational level. Application of political process and other current social movement theories. Pre: 1004. (3H,3C)

3464 (AHRM 3464) (APS 3464) (GEOG 3464) (HD 3464) (HUM 3464) (UAP 3464): APPALACHIAN COMMUNITIES
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

3504: POPULATION TRENDS AND ISSUES
Contemporary American and global population trends in historical and comparative perspective. Discussion of the impact of population change on individual and society. Relevant public policy questions examined. Pre: 1004. (3H,3C)

3614: GENDER AND WORK IN THE U.S.
Examination of the role that gender plays in shaping the experience of work, focusing especially on the persistence of occupational segregation by sex, its causes and implications. Also, the interaction of work and family life, including the allocation of household work and control of resources. Social policies affecting gender relations in work organizations will be analyzed. Pre: 1004. (3H,3C)

3714: SOCIOLOGY OF AGING
Emergence of old age as a social problem. Social aspects of aging in America, including the minority

experience and with some cross-cultural comparisons. Social and demographic characteristics of the aged, location of aged in the social structure, and current and future social problems of old age. Pre: 1004. (3H,3C)

3854: GLOBALIZATION: SOCIOLOGICAL PERSPECTIVES
Distinguishes global from international. Examines social globalization and cultural globalization and what forms they take. Explores changes in the role of nation-states and the implications of global changes in the division of labor for economic, gender, and racial/ethnic inequalities. Discusses how globalization is linked with peace, violence, and human rights. Considers alternative and more equitable forms of globalizations and how social movements might lead to such alternatives. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4014: SOCIOLOGY OF THE FAMILY
The family as a basic social institution: similarities and variations in family systems, their interrelationships with other social institutions, and patterns of continuity and change. Taught alternate years. Pre: 2014. (3H,3C)

4024 (RLCL 4024): SOCIOLOGY OF RELIGION
Religion as a social structure as well as an institution; with special attention to the functions of religion for individuals, groups and societies, social organization; and the interplay between religion and other social institutions including economics and polity. Taught alternate years. Pre: 1004. (3H,3C)

4034: SOCIOLOGY OF EDUCATION
Analysis of the structure, functions, and consequences of schooling in America, the social processes affecting academic achievement, and the implications of current knowledge for educational reform. Taught alternate years. Pre: 1004. (3H,3C)

4044: MILITARY SOCIOLOGY
The military institution and its relationship to society. Emphasis on the role of the military and its social organization; recruitment, socialization, career, combat, deviant behavior, changes in the military, and future trends. Taught alternate years. Junior standing. Pre: 1004. (3H,3C)

4054 (APS 4034): APPALACHIAN LANGUAGES AND CULTURES
An empirical examination of how Appalachian speech both reflects and constitutes regional cultures. Emphasis is on applying sociological and anthropological methods and theories to the study of language in use. (3H,3C)

4094 (APS 4094) (PHS 4094): APPALACHIAN COMMUNITY RESEARCH
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy. (3H,3C)

4114: THE SOCIOLOGY OF POPULAR MUSIC
Examine the social context(s) of popular music, including the social, economic, and political factors that influence the development of different popular music forms; authenticity within popular music genres; popular music's impact on social activity and identity; the institutions that connect popular music producers with consumers. Pre: 1004, 1014 or AFST 1714. (3H,3C)

4124 (RLCL 4124): TOPICS IN CULTURE
Uses sociological, anthropological, as well as artistic and humanist paradigms to analyze culture. Discusses 20th and 21st century cultural trends. Analyzes the implications of social context for cultural artifacts such as art. Topics are variable. Example topics include the cultural construction of race and the cultural of the nineteen sixties. Course may be repeated with different course content for up to 6 credits.

Junior or Senior standing. Pre: 1004 or 1014 or AFST 1714 or AINS 1104 or RLCL 1004 or RLCL 2004 or WGS 1824. (3H,3C)

4194: SENIOR SEMINAR
Required seminar for majors. Integration and application of prior coursework, including reviews of theory and research methods. Application of sociological knowledge toward an actual needs assessment in a work setting, completion of a social policy analysis, and a written critique of a sociological publication. Course serves as a bridge to graduate study, prepares students for application of sociological knowledge, and provides overall career guidance. Senior standing and sociology majors only. Pre: 3104, 3204. (3H,3C)

4204: APPLIED RESEARCH
Stresses differences between applied research and other methodologies. Examines the topics, purposes, problems, theories, and methods appropriate for applied research. Explores ethical and political issues prevalent in applied settings. Includes qualitative, quantitative, and mixed methodologies. Emphasis on survey construction and administration, experimental designs, evaluation research, and participatory action research as used by applied researchers. Includes data analysis and issues of presenting applied research to lay audiences. Pre: 3204, STAT 3604. (3H,3C)

4294: CAPSTONE: DIVERSITY ENGAGEMENT
In-depth examination of core themes of diversity. Explains patterns and relational/intersectional aspects of diversity, including the history and legacies of inclusion and exclusion, from a variety of perspectives. Synthesizes diverse writings on issues of social justice and community, power and privilege. Uses social science theories and concepts of diversity to examine contemporary issues of diversity and to facilitate and interpret community engagement projects based in students' major fields of study. Focuses on collective responsibility to eliminate bias and discrimination through students' community-based project outcomes. This course is restricted to students who have enrolled in the Diversity and Community Engagement Minor. Pre: 2034. (3H,3C)

4304: RESEARCH METHODS TOPICS
Variable topics course that focuses on different research methodologies. Includes topics such as feminist research, qualitative methodologies, survey design, evaluation research, and anthropological methods. Can be taken multiple times if different topic. Pre: 3204, STAT 3604. (3H,3C)

4404: SOCIOLOGY OF LAW
The functions of law as a form of social control. The social forces in the creation, enforcement, and change of the law. The nature of law as a force in social change. Taught alternate years. Pre: 1004. (3H,3C)

4414: DRUGS AND SOCIETY
Examines the use of drugs, including legal and illegal drugs, from a sociological perspective. Cross-cultural and historical patterns of use are discussed and explained. Particular attention is given to drug use within the context of various social institutions. Junior standing. Pre: 1004. (3H,3C)

4444 (PSVP 4444): SCHOOLS, VIOLENCE, AND JUSTICE
Focuses on the nature, extent, causes, and consequences of widely recognized forms of violence within schools, such as bullying, fighting, sexual assaults, harassment, dating violence, and shootings. Examines the effectiveness of violence prevention programs. Includes sociological theories of violence within schools. Explores the social debate over balancing the collective public safety obligations of schools with individual students' rights/responsibilities. Pre: 3414 or CRIM 3414. (3H,3C)

4454: TOPICS IN SOCIOLOGY
A variable topics course in sociology. In-depth examination of topics such as environmental sociology, the sociology of sport and competition, social networks, and sociology of the body. May be repeated 2 times with different content for a maximum of 9 credits. Junior standing. Pre: 3104. (3H,3C)

4704: MEDICAL SOCIOLOGY
Social and cultural response to illness and infirmity. Emphasis on the sick role, patient role, practitioner

role, organization and politics of health care delivery, stratification, professionalism, and socialization of health practitioners. Taught alternate years. Junior Standing. Pre: 1004. (3H,3C)

4714: SOCIOLOGY OF MENTAL ILLNESS
Mental illness and social systems, historically and in contemporary society. Distribution of mental illness with special reference to stratification, role, and deviance theories. Mental health occupations and organization of treatment. Implications for social policy. Taught alternate years. Junior standing. Pre: 1004. (3H,3C)

4754: INTERNSHIP
Placement and sociologically relevant work in one of a variety of human service settings, combined with relevant readings, discussion and written work coordinated jointly by a faculty member and the setting supervisor. Placement settings include human resource agencies, corrections facilities, extension offices, and law agencies. Sociology major or minor required. Junior or Senior standing required. Consent of internship coordinator required. Coursework relevant to placement setting. Variable credit course.

4764 (GEOG 4764) (UAP 4764): INTERNATIONAL DEVELOPMENT POLICY AND PLANNING
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required. (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (WGS)

1824: INTRODUCTION TO WOMEN'S AND GENDER STUDIES
Describes feminism and the field of Women's and Gender Studies. Explains basic theories of social inequality, privilege, oppression and intersectionality. Discusses feminist perspectives on science and culture. Outlines women's and men's relative positions in and contributions to such institutions as family, work and the state. (3H,3C)

2114: FEMINIST THEORY
Examination of diverse theoretical perspectives on women and gender, including their historical origins and political implications. Special emphasis on integrative perspectives that also address race, class, and other dimensions of inequality. Pre: 1824. (3H,3C)

2204 (AFST 2204) (RLCL 2204): RACE AND GENDER IN RELIGION AND CULTURE
Influence of race and gender on religion and culture. Overview of approaches to categories of diversity, particularly race and gender, in religious and cultural traditions. Utilization of humanistic and social

scientific approaches to investigate geographically variable historical and/or contemporary case studies. (3H,3C)

2224: WOMEN AND CREATIVITY
A study of the philosophical, artistic, and biographical dimensions of women's creativity in a wide variety of fields. Pre: 1824. (3H,3C)

2244: WOMEN AND SCIENCE
Uses research from the disciplines of science, women's studies, history, sociology, and philosophy to examine women's roles in the fields of science, technology, engineering, and mathematics. Starting with historical figures, students will follow the progress women have made in entering and succeeding in science careers. Pre: 1824. (3H,3C)

2254: FEMINIST ACTIVISM
Explores the history of individual and collective action geared toward gaining women's rights and improving women's positions in society. Course covers tensions and shifts in feminist movements, as well as the perspectives, agendas, and actions of specific subgroups of women whose perspectives sometimes conflict. Service-learning is a required component of the course. Pre: 1824. (3H,3C)

2264 (AFST 2264) (SOC 2264): RACE, CLASS, GENDER, AND SEXUALITIES
Focuses on how race, class, gender, and sexualities form interlocking systems of privilege and oppression at individual and institutional levels. Emphasizes race, class, gender, and sexualities as changing social constructions and interactive systems that shape social institutions and organizations, meanings, and identities. Pre: 1824. (3H,3C)

2274: WOMEN IN THE MILITARY
This course covers historical and global perspectives on the experiences women have had in and with the military. This course introduces students to issues concerning women fighters and military families, as well as to debates over women in combat positions, military policies, and globalization. (3H,3C)

2284: LESBIAN, GAY, BISEXUAL, TRANSGENDER AND QUEER ISSUES
Introduces students to Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ) Studies. Focuses on sexuality and gender as historical and cultural constructs. Examines the experiences of individuals who do not conform to binary sex-gender systems and the development of diverse identities and LGBTQ communities. Introduces feminist and queer theories that address LGBTQ issues within social, political, legal, and cultural institutions. Examines the institutional oppression of sexual minorities and implications of the intersectionalities of such systems of inequality as gender, race, ethnicity, class, age, and (dis)ability. Pre: 1824. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: TOPICS IN FEMINISM
A variable topics course that addresses how the social construction of gender shapes social, cultural, political, economic, and institutional structures as well as individual experiences and perceptions. The course stresses interdisciplinary approaches to topics of emerging interest in feminist scholarship. Can be taken up to three times for credit with varying topic. In addition to WS 1824, must have taken a 2000-level Women's Studies course, or have instructor's consent. Pre: 1824. (3H,3C)

3014 (RLCL 3014): WOMEN AND GENDER IN ISLAM
An examination of women and gender in Islam from a variety of perspectives including Muslim women in Islamic history, normative constructions of the roles of women in Islam, and women's role in contemporary Muslim societies. Understanding of women in classical Islam; feminist and reformist approaches; and Western constructions of the "rights of women in Islam." (3H,3C)

3134 (ENGL 3134): GENDER AND LINGUISTICS

Exploration of differences--real and imagined--in the speech of men and women, and the relationship between these differences to culture. Exploration of how language can reflect and reinforce gender inequality. Linguistic phenomena covered: pitch, vocabulary, sound change, language ideologies, and discourse strategies and types. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

3214: GLOBAL FEMINISMS
An introduction to the gendered analysis of global women's issues with a special focus on women of color. Examines the multiple and diverse sites of feminist struggle within the third world, and between first and third worlds both in the U.S. and internationally. Studies the impact on women of political movements such as nationalism, colonialism, revolution, authoritarianism and democracy. Compares theories originating with women of color in the U.S. with those from international third worlds. Pre: 2264. (3H,3C)

3324: PERSPECTIVES ON THE BIOLOGY OF WOMEN
Examines historical, social, and cultural views of women's biology and how those views have impacted women's physical and mental health. Special attention is paid to the influence of cultural traditions and beliefs on scientific perspectives. Pre: 1824. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4214 (GEOG 4214) (UAP 4214): GENDER, ENVIRONMENT, AND INTERNATIONAL DEVELOPMENT
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing. (3H,3C)

4224: WOMEN'S STUDIES SEMINAR
This multi-disciplinary, multi-cultural course examines a significant topic in Women's Studies, utilizing the perspectives of history, biology, psychology, political science, sociology, and the arts. Variable topics. Pre: 1824, 2114. (3H,3C)

4334 (STS 4334): SEXUAL MEDICINE
Discusses sex and medicine in contemporary U.S. society. Explores how notions of sexual behavior and "normality" are defined and structured by medical discourse. Examines cultural institutions that play significant roles in formulating ideas about and definitions of deviance, perversity, and tolerated marginality. Critiques medical responses to sexual variations. Examines experiences of people who have sought out, or been the unwilling victims of, sexual medicine. Junior standing required. Pre: 1824. (3H,3C)

4704 (STS 4704): GENDER AND SCIENCE
Investigates the gender dimensions of science in both historical and contemporary perspectives. Discusses feminist studies of science, exploring strengths and limitations. Assesses implications of cultural assumptions about gender for practicing scientists. A 3000 level course in science or engineering may satisfy prerequisite. Pre: 2244 or STS 1504. (3H,3C)

4754: INTERNSHIP
Qualified students will be placed with a community agency or on-campus office which addresses contemporary issues of gender, class, and/or race, and will meet periodically with an appropriate faculty member to discuss assigned readings that will provide a context for the work experience. Students will also be expected to keep a journal and to write up a final evaluation of the experience. Variable credit: may be taken for up to 6 elective credits in the Women's Studies concentration. Junior standing, screening interviews with Tech faculty and with the service agency and consent required. Variable credit course. Pre: 1824.

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY

Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

School of Visual Arts

Director: Kevin Concannon
Associate Professors: M. Casto, T. Head, A.M. Knoblauch, M. Moseley-Christian, E. Standley, S. Blanchard, and T. Tucker
Assistant Professors: M. Borowski, M. Dee, Z. Duer, P. Finley, J. Joiner, K. Meaney, W Lages, N. King, L. Duffield and R. Weaver
Instructors: D. H. Bannan, J. Hand, H. Okumura, J. Rosenthal, A. Salisbury, and D. Sim
Armory Art Gallery Director: D. Sim
Academic Adviser and Recruiter: Tracey Proco Drowne
Director of FourDesign: J. Joiner
Program Chairs: Art History and Visual Culture - M. Moseley-Christian, Graphic Design - M. Dee, Creative Technologies – L. Duffield and R Weaver, Studio Arts – S. Blanchard and Visual Arts Minor – J. Jewitt
Area Coordinators: Foundations of Art – J. Hand

Web: **www.sova.vt.edu**

Overview

The School of Visual Arts (SOVA) offers studio-based programs in the visual arts balanced with the study of the history, theory, and criticism of visual and material culture. The faculty includes both practicing artists and scholars of art history. The School emphasizes new digital media as well as traditional artistic media. SOVA offers a B.F.A. degree with concentrations in Graphic Design, Creative Technologies and Studio Arts; a B.A. in Art History and Visual Culture, a minor in Art History and a minor in Visual Arts.

SOVA provides a variety of exhibitions and art events. The Armory Art Gallery exhibits work by national and regional artists and provides students and regional artists the opportunity to create and show wide-ranging experimental work. The Collaboration for Creative Technologies in Arts and Design (CCTAD) is a cross-disciplinary initiative with Art, Music, Computer Science and Communications. The Digital Arts and Animation Studio (DAAS) is designed to facilitate this new concentration.

FourDesign, a University Service Center, provides students with vital professional design experience. Student interns work in a team environment under the direction of FourDesign faculty to produce design work for clients, providing professional and entrepreneurial experience rarely available to undergraduates. Through visiting artists and scholars, the School also brings students and members of the art community into dialogue with artists and critics of international prominence.

SOVA participates in the University's Education Abroad program, which is open to students at the sophomore level or above and combines classroom study with travel-study tours in Europe, Cuba, and Latin America.

Foundations of Art and Design is a year-long, entry-level intensive program that prepares students for advanced study in the visual fields of integrative Studio Art, Creative Technologies and Graphic Design. The two-semester, 1000-level curriculum is made up of 15 credit hours covering principles of art and design, drawing, and digital imaging proficiency. Completion of the entire Foundation program is required of B.F.A. students prior to taking SOVA courses that are 2000 level or higher.

The investigation and unification of dexterity, contextual dialogue, and presentation skills are at the heart of the Foundations of Art and Design program at SOVA. Rather than isolating craft at the foundational level of study, whole elements of visual language are fostered equally. This unified approach to art and design studies aim to develop:

- Innovation and creative leadership skills
- Visual logic through multimedia
- Confidence with digital and analog crossover
- Traditional awareness applicable to contemporary tools of production

Portfolio Review

Students must pass the annual Portfolio Review in order to enter the B.F.A. programs in Studio Art, Creative Technologies, or Graphic Design. The SOVA Foundations of Art and Design curriculum supplies students with the necessary information and proficiency to compete in Portfolio Review.

Studio Art, Creative Technologies, and Graphic Design candidates must be currently enrolled or have passed three foundation courses (ART1204 Principles of Art and Design, ART1404 Drawing 1 and ART1604 Principles of New Media). Acceptance is contingent on successfully passing all three of these courses. The Studio Art, Creative Technologies, and Graphic Design review committees (comprised of SOVA Faculty) screen student work for outstanding qualities in artistic ability, creativity, presentation skills and overall motivation.

Bachelor of Fine Arts in Studio Art

The SOVA Studio Art program offers classes in painting, drawing, sculpture, and photography. We aim to prepare artists for the digitally enhanced world by integrating emerging technologies into a contemporary fine arts experience. Our students have access to cutting edge technologies like laser cutters, CNC routers and 3D printers, and are taught in an environment that encourages them to explore these tools in conjunction with traditional mediums. Students and faculty conduct research and create work that spans disciplinary

boundaries. Our flexible undergraduate curriculum provides opportunities for students to achieve interdisciplinary breadth through electives in Graphic Design, Creative Technologies, and other areas of personal interest.

Situated within a nationally recognized research institution, SOVA attracts students and faculty who value the study of art in a broad cultural and intellectual context. The B.F.A. degree in Studio Art equips emerging artists with critical thinking skills, visual and cultural literacy, and tools to communicate their ideas. We also promote the professional skills and habits necessary to build and sustain a self-directed studio practice. Our program is uniquely positioned to provide students with the skills and opportunities to explore the impact of art and technology on our lived experience.

Graduates of the Studio Art program apply their creative skills in a variety of careers. Some become professional artists, exhibiting at national galleries and museums, or pursue commercial careers in photography, painting, illustration, and sculpture. Others seek their Master of Fine Arts (M.F.A.) in specific studio disciplines or post-graduate degrees in related arts fields such as Material Culture, Art Therapy, Art Education, Exhibition Design, and Art Conservation. Our alumni have gone on to become professional artists, university professors, K-12 teachers, and pursue careers in galleries and museums.

The Bachelor of Fine Arts degree in Studio Arts is a 78 credit-hour program. Each faculty member is dedicated to teaching, research, and outreach within his or her specific fields. The connection from professional practice to studio classroom is essential in creating applicable learning environments.

The goal of the program is to develop culture-enriching leaders and innovative visual artists. Completing an integrated path of study in the Studio Arts program will result in a B.F.A. degree that is applicable to the demands of the visual arts industry.

Bachelor of Fine Arts in Creative Technologies

The Creative Technologies program focuses on computer-based digital arts, including animation, creative coding, interactive installations, etc. Classes are taught by active artists and scholars with experience integrating emerging creative technologies into new media art contexts as well as applications in industry.

The Creative Technologies concentration consists of 75 credit hours, with 21 required credits and additional elective offerings that can be clustered so that students obtain specialization in immersive virtual environments, code and form or the moving image.

In the Creative Technologies program, students learn cutting-edge software in a creative environment, preparing them for employment in industry or further studies in graduate school.

Bachelor of Fine Arts in Graphic Design

The Graphic Design program is notable for its practical and applied approach to design pedagogy. Students concentrating in Graphic Design develop conceptual abilities, problem solving skills and technical know-how required by a fast-paced, competitive field. Graphic Design demands individual creativity, teamwork skills, and adaptability to changing markets and technologies. The Graphic Design program at Virginia Tech prepares students for the job market with practical experience and a full, professional portfolio. Graduates of the program may find themselves working in print design, product and packaging design, multimedia web page design, and advertising design. Coursework in 3D animation and interactive design allows students to explore emerging design technologies.

Entry into this program is restricted and requires successful completion of specific criteria. See **Portfolio Review** above. Students accepted into Graphic Design begin the course sequence in the spring semester. From that point on, the course sequences are uniquely tailored to Graphic Design students.

Bachelor of Arts in Art History and Visual Culture

This program is oriented toward the history of western art, although courses are frequently offered on non-western topics. The foundation for the study of art history in SOVA is a two-semester survey of the history of art. At the intermediate level, there are fourteen courses offered on a regular basis, ranging from ancient Egyptian art and architecture to Art Since 1900, and including archaeology, arts of China and Japan, and the history of graphic design. Upper-level courses are designated as special topics courses. In recent years, they have ranged from the Seven Wonders of the World to Japanese prints to the History of Photography to the Preservation of Historic Interiors.

The major in Art History and Visual Culture is a 42-credit degree. In addition to the two semester Survey of the History of Art (2385-86), students are required to take five courses at the 3000-level. The five courses are chosen from a list of four historical categories, ensuring students study art and architectural history over a broad historical range. In addition, majors are required to take Topics in Criticism and Methodology (Art 4484) and three upper-level topics classes (Art 4384).

To provide a broader context for the history of art, majors are also required to take a history course and a humanities course (focusing on broad cultural and historical periods). To ensure some 'hands on' experience, they are also required to take either Art 1204 (Principles of Art and Design) or Art 1404 (Basic Drawing). The program encourages students to take advantage of opportunities to study abroad and to serve as interns in cultural organizations, especially museums and historical sites.

Minor in Art History

The minor in art history is an 18-credit degree. It consists of the two-semester Survey of the History of Art (Art 2385-86) and two courses at the 3000-level and two at the 4000-level.

Visual Arts Minor

Hosted by the School of Visual Arts with collaboration from numerous departments across Virginia Tech, the interdisciplinary Visual Arts Minor leads students to explore art as a lens through which to view society. It encourages the cultivation of visual intelligence—through both study and practice-based approaches in studio art—relevant to our increasingly visual, media-saturated world and demanded in a variety of STEM and humanities fields. Students learn flexible visual skills and how to apply them to multiple disciplines inside and outside their major, such as business, medicine, law, and the natural sciences. The result is a comprehensive understanding of art and the built environment in a global context, as they intersect with the complexities of historical and contemporary society.

Requirements for the Minor include four core courses—ART 1104, ART 1004, ART 2385/6, ART 4104—and two elective courses in the social sciences, totaling 18 credit hours.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of expected date of graduation. Requirements for graduation are referred to via publications as "Check sheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The Virginia Polytechnic Institute and State University reserves the right to modify requirements in a degree program. However, the University will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Undergraduate Course Descriptions (ART)

1004: TOPICS IN STUDIO ART FOR NON-MAJORS
Variable introductory topics on practice-based studio art, ranging from 2D, 3D and Digital Imaging concentrations. Multiple projects with emphasis on media specific creations using introductory studio practices, practice-based technical and conceptual knowledge to achieve expressive communication. Analyze and critique creative works within historical and cultural context. May be repeated with different topics, for a maximum of 12 credit hours. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)

1104: LANGUAGE OF VISUAL ARTS
Introduces key formal structures across the broad variety of disciplines in the visual arts and built environment, including: architecture, painting, sculpture, photography, and film. Considers global objects and sites from an intercultural perspective, examining how various formal elements impact our experience and function to construct meaning for audiences. Writing informed arts criticism grounded in local and regional cultural resources. RESOURCE CHARGE. (3H,3C)

1114: PLAY TO MAKE-MATERIALS, TOOLS, PROCESSES-CREATIVE TECHNOLOGIES+EXPERIENCES
Transdisciplinary practice in an inclusive, collaborative environment, through the lens of creative technologies and experiences, to describe and evaluate the convergence between art, technology, and human experience in the arts, sciences, humanities, and engineering. Exploration of play for creation of ideas and artifacts (including, but not restricted to multimedia narratives, learning simulations, immersive/performative experiences, and data exploration). Inclusive collaboration with peers and practicing professionals in diverse fields. Critical consideration of creative technologies and the impacts on history, society, cultures, individuals, and communities. Collaborative research, design, creation, and exhibition of a transdisciplinary project to identify and address a global challenge. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H,5L,3C)

1204: PRINCIPLES OF ART & DESIGN I
Introduction of two-dimensional principles of design through employment of traditional and digital media. Reference to historical and theoretical context strengthens proficiency in the language of design. Application of contemporary practices and ethics. Projects, applied problem solving, reading assignments and critiques supply graphic skills and specialized vocabulary. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)

1214: PRINCIPLES OF ART & DESIGN II
Introduction of two-dimensional principles of design through employment of traditional and digital media. Reference to historical and theoretical context strengthens proficiency in the language of design. Application of contemporary practices and ethics. Projects, applied problem solving, reading assignments and critiques supply graphic skills and specialized vocabulary. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 1204, 1404. (1H,5L,3C)

1234: TOPICS IN VISUAL COMMUNICATION DESIGN FOR NON-MAJORS
Variable introductory topics on visual communication design, ranging from contemporary issues in design to development of formal design skills. Multiple projects with emphasis on problem-solving with an awareness of target audiences from various backgrounds, historical and cultural contexts, and STEEP (Social, Technological, Economical, Environmental, and Political) principles. Explores knowledge of design principles and vocabulary using a range of materials and methodologies. Examines needs of diverse users, applied via digital translations and appropriate software. May be repeated for up to a maximum of 12 credit hours with varying or different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). (1H,5L,3C)

1304: GATEWAY TO ART AND DESIGN
First Year Experience course for students seeking entry into BFA degree program. Developing a successful path of study in the School of Visual Arts BFA degree using advising resources; introduction to professional and ethical visual arts practices through presentations with local and regional artists; visits to local and regional galleries; presentations by university faculty and staff related to the BFA. Introduction to visual thinking using the Virginia Tech Common Book and preparation for portfolio review. Art History majors are not required to take the course. Co: 1204, 1604, 1404. (1H,1C)

1404: DRAWING I
Methods and concepts fundamental to drawing, for the beginning student. No previous experience necessary. Emphasis on controlled use of common drawing media for representational and expressive purposes. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)

1414: DRAWING II: LIFE DRAWING
Drawing the human figure from life. Emphasis on observation, construction, and anatomy. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 1404, 1204, 1604. (1H,5L,3C)

1604: PRINCIPLES OF NEW MEDIA ART & DESIGN
Introduces the student to the concept of new media through the research and development of contemporary art and design. The creative and aesthetic potential of the computer will be explored to produce new media product. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)

1614: PRINCIPLES OF VISUAL COMMUNICATION DESIGN
Introduction to design theory, practice, and visual communication skills. Projects, applied problem solving, reading assignments, and open critiques incorporate graphic competencies and vocabulary specific to the field of visual communication design. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: 1204, 1404, 1604. (1H,5L,3C)

1984: SPECIAL STUDY
Variable credit course.

2385,2386: SURVEY OF THE HISTORY OF WESTERN ART
Survey of the visual arts and architecture from prehistoric times to the present day with emphasis on Western Europe including functions of visual arts and architecture, terms of visual literacy and methods of formal visual analysis. 2385: Focus on prehistoric time to the thirteenth century including Paleolithic, Neolithic, Ancient Near Eastern, Egyptian, Aegean, Greek, Roman, Byzantine, medieval and early Gothic art. 2386: Focus on late Gothic through present day including Renaissance, Baroque, 19th (Romanticism to Post-Impressionism) and 20th centuries (cubism to postmodernism). (3H,3C)

2514: DRAWING CONCEPTS
Exploration of drawing practices that reflect expansions in the discipline through examination of the work of contemporary artists and discussion of recent historical precedents. Examination of multiple viewpoints through readings and discussion investigating notions of identity, culture, and social reality. Development of personalized visual language and content through iterative drawing processes. Application of formal analysis and interpretive strategies through critique. Includes traditional and experimental techniques; representational, abstract, and nonobjective approaches to drawing. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab Studio (2L,1C). RESOURCE CHARGE. Pre: 1414. (1H,5L,3C)

2524: INTRODUCTION TO PAINTING
Students will explore painting practices and their relationship to art and design in contemporary culture, and develop basic painting skills and an understanding of various painting media. Encompasses illustrational technique and practical applications, expressive and abstract approaches to painting. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 1204, 1404, 1604. (1H,5L,3C)

2544: CERAMICS I
Basic investigations into the materials, techniques, history and appreciation of the ceramic arts. Ceramic processes and technology including hand forming construction methods, glazing, and kiln firing. Design concepts as they relate to clay objects are stressed. Historic and contemporary ceramics objects along with methods and traditions of cultures from around the world will be introduced through a range of media. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 1204, 1404, (1604 or 1504). (1H,5L,3C)

2554: INTRODUCTION TO SCULPTURE
An introduction to sculptural processes and materials in art and design. Intensive studio work on individual projects. Review of historical and contemporary issues as applied to the definition of space, texture, mass, volume, scale and other principles of three-dimensional art. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: (1204, 1404), 1604. (1H,5L,3C)

2565-2566: TYPOGRAPHY
Foundational study of Typography as it relates to Visual Communication Design including historical and contemporary context. Study of the formal principles of typographic design of both printed and digital matter. Overall focus on letterforms, design structures, and grid systems. Pre: Admittance to Visual Communication Design Program. 2566: Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition. Pre: 2565. 2565: I, II. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). (1H,5L,3C)

2565H-2566H: TYPOGRAPHY
Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition. (1H,5L,3C)

2575-2576: INTRODUCTION TO GRAPHIC DESIGN
Introduction to the theory and practice of graphic design as a means of visual communication, exploring problem-solving as applied to design concepts and execution. Studio assignments relating to society, industry, community, and commerce, with emphasis on digital/electronic applications. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 1604, 1204, 1404 for 2575; 2575 for 2576. Co: 1414 for 2575. (1H,5L,3C)

2604: INTRO TO NEW MEDIA ART
An introduction to digital time-based technologies to develop new media products including, stop-motion videos, 2D animations and interactive projects for delivery on the Internet. Aesthetic ideas and concepts of new media art will be examined. RESOURCE CHARGE Pre: 1604. (1H,5L,3C)

2644: CERAMICS II
Introduction to forming methods using the potter’s wheel. Design concepts, techniques and approaches to creating functional forms. Overview of contemporary and historic utilitarian ceramics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 2544. (1H,5L,3C)

2664: DIGITAL PHOTOGRAPHY
Concepts, terminology, and skills in digital photography. Discover and utilize the appropriate techniques for camera control, exposing techniques, image manipulation and approaches to output options. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Each student MUST own a digital SLR camera. RESOURCE CHARGE. Pre: 1604. (1H,5L,3C)

2704: 3D COMPUTER ANIMATION
ntroduction to the basic principles of 3d-computer animation including modeling, texture mapping, lighting, and motion. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) RESOURCE CHARGE. Pre: 1204, 1404, 1604. (5L,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3004: TOPICS IN ART HISTORY
Rotating topics from all periods of art history with a particular emphasis on non-Western art, such as

Japanese, Chinese, pre-Columbian, sub-Saharan, Native American, or Islamic art and architecture. Lecture and/or undergraduate seminar format. May be repeated for credit with different content for a maximum of 9 credits. Pre: 2385 or 2386. (3H,3C)

3054: ISLAMIC ART AND ARCHITECTURE
Survey of the visual arts and material culture produced in Islamic cultures from its origins in the 7th century CE (Common Era) through the contemporary period. Focus on analyzing transnational exchanges and influences that shape the visual and material culture of Islamic regions including architecture, the graphic arts, painting, ceramics, and textiles within cultural, geographic, political, and religious contexts. Includes artifacts and architecture from Iraq, Iran, the Arabian Peninsula, Egypt, Turkey, India, Spain and notable sites from North Africa and Central Asia. (3H,3C)

3064: ARTS OF CHINA AND JAPAN
An introduction to Chinese and Japanese art from the Neolithic to the present. The influence of philosophy, religion and social organizations on the development of the visual arts in China and Japan. Considers a range of media including painting, sculpture, calligraphy, ceramics, prints, and architecture in contexts of Imperial and post-Imperial patronage. (3H,3C)

3074: EGYPTIAN ART AND ARCHITECTURE
Introduction to Egyptian art and architecture from the Predynastic through the Late Period with emphasis on the major monuments of Egyptian sculpture, painting and architecture. Emphasis on Egyptian art in the context of the unique landscape of the Nile River and surrounding desert, the art of contemporary cultures in the eastern Mediterranean world, and the history of archaeological exploration within the region. (3H,3C)

3084: GREEK ART AND ARCHITECTURE
Painting, sculpture, and architecture of the Greeks, ca. 1000-31 B.C. Emphasis on correlation of archaeological remains with literary sources, and on the development of the arts in relation to cultural environments of the archaic, classical, and Hellenistic periods. Pre: 2385. (3H,3C)

3094: EARLY MODERN GLOBAL VISUAL CULTURE
Visual and material culture in the context of global travel, trade, and foreign contact during the Early Modern period. Artistic exchanges through contact between Europe, the New World, Islamic lands, Japan, China, and colonial Africa. Material as cultural artifacts, commodities, and transmitters of new technologies and scientific knowledge. (3H,3C)

3114: CREATIVE CODING FOR CREATIVITY AND INNOVATION
Introduction to computer programming tools within a critical aesthetic context. Creation and analysis of generative and algorithmic artwork as well as consideration of how works derived from logical rulesets, algorithms, and the artful application of randomness can communicate human feelings and ideas. Consideration of ethics of algorithmic systems in our culture and media, and creating art works to address those issues and influence opinion. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). Pre: 1114. (1H,5L,3C)

3174: INTRODUCTION TO ARCHAEOLOGY
Introduction to archaeology focusing on a history of the discipline of archaeology with an emphasis on Mesopotamia and the Mediterranean world. Evolution of field inquiry and techniques in the context of major historical personages and excavations in Egypt, Greece, Italy and Syro-Palestine, as well as contemporary global and ethical issues surrounding the preservation and protection of archaeological artifacts, particularly with regards to the role they serve and their use and misuse as non-renewable global objects of cultural heritage and cultural identity. (3H,3C)

3184: ROMAN ART AND ARCHITECTURE
Painting, sculpture, and architecture of the Romans 500 B.C. - 323 A.D. Emphasis on relation between monuments and the political and cultural circumstances that led to their creation. Pre: 2385. (3H,3C)

3284: MEDIEVAL ART AND ARCHITECTURE
Artistic traditions of the medieval world from the fourth to fifteenth centuries with a focus on diverse cultural exchanges between Byzantine east and Latin west, along with Islamic contact. Stylistic, thematic, and formal

developments in sculpture, painting, textiles, metalwork, architecture, book arts within social, political, and religious contexts. (3H,3C)

3384: RENAISSANCE ART AND ARCHITECTURE
A chronological survey of Renaissance art analyzing painting, sculpture, the graphic arts, and architecture. Develops visual literacy through an evaluation of major stylistic and thematic trends within the study of historical context, artistic techniques and processes, iconography, patronage, economy, religion, political structures, and emerging sciences. (3H,3C)

3484: BAROQUE AND ROCOCO ART AND ARCHITECTURE
Art and architecture of the seventeenth-century Baroque and eighteenth-century Rococo with with an emphasis on form, style, and cultural contexts for painting, sculpture, and architecture. A study of major artists, themes, styles, and technical artistic processes in Italy, Spain, Flanders, Holland, England, France in contexts of global expansion. Seventeenth-century visual culture in its historical, religious, economic, social, and ethical contexts. (3H,3C)

3504: TOPICS IN DIGITAL ART AND DESIGN
Rotating topics that explore the computer as an artistic medium and design tool. Intermediate level. The student will encounter as interdisciplinary approach to the use of the computer, as aesthetic ideas are presented and various digital techniques are applied. Stresses use and manipulation of original images created by the student, employing a combination of digital and traditional methods. May be repeated with different content for a maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) Resource Charge. Pre: 2604. (5L,3C)

3514: TOPICS IN DRAWING
Rotating topics in drawing media, approaches, and theories. All topics will be devoted to promoting individual student creativity, mastery of drawing means and techniques, and further understanding of graphic concerns. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). May be repeated for a maximum of 9 hours with different topics. RESOURCE CHARGE. Pre: 1414 or 2514. (1H,5L,3C)

3524: TOPICS IN PAINTING MEDIA
Rotating topics in painting techniques, disciplines, and theory emphasizing individual creative development and skilled approaches to technical problem-solving in visual art and design. Intermediate level. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: 2524. (1H,5L,3C)

3544: TOPICS IN CERAMICS
Rotating Topics in special techniques, processes, design concepts and forms in the ceramic arts. May be repeated for a maximum of 12hours with different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). FEES REQUIRED. Pre: 2644. (1H,5L,3C)

3554: TOPICS IN SCULPTURE
Rotating topics that will focus on specific technical processes and applications of three dimensional problem solving in the visual arts. The course will stress techniques and issues found in contemporary 3D art and design. Emphasizes intensive studio practice through a series of individual projects related to the topics. FEES REQUIRED. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: 2554. (1H,5L,3C)

3564: TOPICS IN PHOTOGRAPHY
Rotating topics in photographic materials, methods and philosophies. All topics promote individual student’s creativity, master of photographic techniques and further understanding of the medium. May be repeated with different topics for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 2664. (1H,5L,3C)

3565-3566: INTERMEDIATE GRAPHIC DESIGN I AND II
Intermediate design layout, technical and concept development, and communication skills. First semester emphasizes advanced and new software relevant to the design, advertising, and printing industry. Second

semester focuses on typography, professional pre-press, electronic printing and color separation processes. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. Pre: 2576 for 3565; 3565, 3565 for 3566. (1H,5L,3C)

3574: TOPICS IN GRAPHIC DESIGN
Rotating topics in graphic design, for the intermediate level student. This course will encourage visual problem-solving, conceptual development, clarity and individuality of expression. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: 2576. (1H,5L,3C)

3574H: TOPICS IN GRAPHIC DESIGN
Rotating topics in graphic design, for the intermediate level student. This course will encourage visual problem-solving, conceptual development, clarity and individuality of expression. May be repeated for a maximum of 12 credits. Pre: 2576. (1H,5L,3C)

3584: NINETEENTH CENTURY EUROPEAN ART: NEOCLASSICISM TO POST-IMPRESSIONISM
European art and material culture of the nineteenth-century. A chronological study of the major artists, artistic movements and styles from neoclassicism to post-impressionism. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, ethnicity and colonialism in the production of art and material culture. (3H,3C)

3604: TOPICS IN NEW MEDIA ART
Rotating topics explore the computer as an artistic medium and design tool. An interdisciplinary approach to the use of a computer. Aesthetic ideas and application of digital techniques. Use and manipulation of original images created by the student, employing a combination of digital and traditional methods. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C). RESOURCE CHARGE. Pre: 2604. (5L,3C)

3674: HISTORY OF PHOTOGRAPHY
A chronological history of photography, from its invention in the nineteenth-century to the emergence of digital technology. Emphasis on historical, sociological, cultural, and global contexts. Addresses terminology and visual analysis, inventions, individual photographers, famous photographs, and issues of inclusion and critical discourse. (3H,3C)

3684: AFRICAN-AMERICAN ART
African-American art and material culture, from its beginnings in the tribal traditions of Africa to its contemporary manifestations. A chronological study of the major artists, movements and styles. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, and ethnicity in the production of art and material culture. (3H,3C)

3704: TOPICS IN COMPUTER ANIMATION
Rotating topics that explore the artistic and design potential of computer animation. Using current digital techniques and methods, focus is on the creation and manipulation of virtual character designs. Students will use an interdisciplinary aesthetic approach to investigate computer animation concepts. May be repeated for credit maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C). RESOURCE CHARGE. Pre: 2704. (5L,3C)

3704H: HONORS TOPICS IN COMPUTER ANIM
Rotating topics that explore the artistic and design potential of computer animation. Using current digital techniques and methods, focus is on the creation and manipulation of virtual character designs. Students will use an interdisciplinary aesthetic approach to investigate computer animation concepts. RESOURCE CHARGE. May be repeated for credit maximum of 12 credits. Variable credit course.

3774: HISTORY OF MODERN GRAPHIC DESIGN
A chronological survey of the history of modern graphic design, from the mid-19th century to 1980. Pre: 2386. (3H,3C)

3784: EUROPEAN AND AMERICAN ART SINCE 1900
European and American Art since 1900. A chronological survey of painting and sculpture from neo-

impressionism through post-modernism. Pre: 2386. (3H,3C)

3854: PROFESSIONAL STUDIO PRACTICES
An overview of professional studio art practices, concepts, marketing strategies and promotional materials. The international exhibition system and current educational opportunities, employment and career options in the visual arts are presented. Preparing of written materials and documenting artwork, building a professional portfolio for presentation to potential employers, art galleries and exhibitions are stressed. Pre: Bachelors of Fine Arts (BFA) majors only. (3H,3C)

3884: AMERICAN ART TO 1914
American art and material culture from Pre-Columbian past to the early 20th century. A chronological study of the major artists, artistic movements, and styles. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, and ethnicity in the production of art and material culture. (3H,3C)

3954: STUDY ABROAD
Variable credit course. X-grade allowed.

3984: SPECIAL STUDY
Variable credit course.

4104: INTERPRETATION OF VISUAL ARTS
Capstone seminar for the Pathways Minor in the Visual Arts and Society. Introduces methodologies, theories, and interpretive strategies commonly used to analyze the visual arts and architecture. Focuses on various critical case studies of global objects and sites ranging from the prehistoric to contemporary periods in the fields of: painting, sculpture, architecture, photography, and film. Assignments explore regional arts resources in these media and develop discursive skills employed in written and oral presentations. Considers ethical and political issues surrounding interpretation of art, as well as attendant epistemological challenges. Pre: Six credits of social sciences from Pathways Minor in the Visual Arts and Society checksheet. Pre: 1104. (3H,3C)

4384: TOPICS IN ART HISTORY
Advanced art history elective. Rotating topics from all periods of art history, selected to complement offerings at the 3000-level. Topics such as Greek Sculpture, Roman Painting, Renaissance and Baroque Sculpture, Cubism, and Fauvism indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated for credit for a maximum of 18 credits. Pre: 2386. (3H,3C)

4484: TOPICS IN ART CRITICISM AND METHODOLOGY
Advanced art history elective. Rotating topics in the criticism of art and the methodology of art history and criticism, selected to complement offerings at the 3000-level. Topics such as the History of Art Criticism from Baudelaire to the Present, New Methods in Renaissance and Baroque Art History, and the Theory of Art from various periods, indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated for credit with different content to a maximum of 9 credits. Pre: 2385 or 2386. (3H,3C)

4504: TOPICS IN MULTIMEDIA STUDIO
This studio course investigates computer-based multimedia in the visual arts and applied design. Video, photography, computer art and design may be used with traditional media and communication vehicles. May be repeated for a maximum of 9 credits. Two 3000-level courses required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: (1414, 1604) or (1504, 1514, 2504). (1H,5L,3C)

4514: INTERARTS STUDIO
This studio course will investigate new approaches to art-making and new genres, such as performance art and site-specific installation. Interdisciplinary basis for course may incorporate traditional studio practices and media in the visual arts, music and theatre arts, and appropriate technology in computer, video, and film. May be repeated for a maximum of 12 credits with different topics. 3000-level course in Studio or Art History or departmental approval. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)

4524: PICTORIAL ARTS STUDIO
Rotating topics in the two dimensional arts, at an advanced level. All topics will challenge the student to

develop stronger, independently generated work of portfolio quality. May be repeated for a maximum of 9 credits with different topics. 3000-level Painting or Drawing course required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE Pre: 3524 or 3514. (1H,5L,3C)

4534: TOPICS IN APPLIED ART AND DESIGN STUDIO
Rotating topics about functional art and design. Students will use appropriate materials, tools, and processes in the creation of functional artworks, such as furniture, tiles, tableware, etc. Function and design aesthetics emphasized. May be repeated for a maximum of 9 credits with different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE Pre: 3544. (1H,5L,3C)

4544: COMPUTER ANIMATION STUDIO
Advanced animation course focusing on the creation of short films, demo reels, and expressive computer animated films. Students enrolled in this course are expected to complete one large project during the semester. May be repeated with different course content for up to nine credit hours. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) Pre: 3704 or 3704. (5L,3C)

4554: SPATIAL ARTS STUDIO
Advanced level, rotating topics in the three dimensional arts. All topics will challenge the student to develop stronger, independently generated work of portfolio quality. May be repeated for a maximum of 9 credits with different topics. 3000-level Ceramics, Sculpture or Applied Art course required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE Pre: 3554. (1H,5L,3C)

4564: EXHIBITION DESIGN AND DISPLAY
This course will focus on the display and presentation of visual art, for student-designed exhibitions. Provides experience in the public art arena, and practical k arena, and practical knowledge about planning, designing, and mounting an exhibition. Pre: 3000-level Studio or Art History course required. (1H,5L,3C)

4574: ADVANCED VISUAL COMMUNICATIONS
A further refinement of design theory and practice, and communication skills. Emphasis on the conceptual development of expanded project formats, and individual creativity. This class will provide a principal opportunity for building a viable portfolio. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE 6 credits of Art 3574 required. Pre: 4504. (1H,5L,3C)

4575-4576: ADVANCED VISUAL COMMUNICATION DESIGN
Refinement of design theory, practice, and communication skills. Emphasis placed on methodologies and strategies for developing a personal identity, website, and/or multimedia portfolio. Development of professional brand identity through web design, design of business cards, letterhead, envelopes, and electronic media. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: 3566 for 4575; 4575 for 4576. (1H,5L,3C)

4584: ADVANCED TYPOGRAPHY
Advanced study of Typography as it relates to Visual Communication Design including historical and contemporary context. Terminology and advanced applications of Typography, complex grid systems, experimental typographic methods, and material studies. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). Pre: 2566. (1H,5L,3C)

4754: INTERNSHIP
Variable credit course. X-grade allowed.

4804: NEW MEDIA ART THEORY
Exploration of new media theory in relationship to contemporary arts practice. Overview and application of new media art aesthetics, strategies, trends, and socio-cultural aspirations. The course will examine theoretical writings and creative work from prevailing technologically-based disciplines. Pre: 2385, 2386. (3H,3C)

4894: SENIOR STUDIO

Preparation and presentation of concentrated studio work under faculty supervision, culminating in solo exhibition and/or formal portfolio. May be extended over two semesters with final grade assigned on completion. Or may be repeated for a total of 6 credits at a maximum of 3H, 3C per semester. Senior standing and consent of department head required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). (1H,5L,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

School of Plant and Environmental Sciences

Head: Michael Evans
Associate Director for Undergraduate Programs: Benjamin Tracy (231.8259, bftracy@vt.edu)
Thomas B. Hutcheson, Jr. Professor: W. L. Daniels
W. G. Wysor Professor: C. Griffey
Professors: A. O. Abaye, E. Beers, J. F. Derr, M. J. Eick, J. D. Eisenback, G. K. Evanylo, J. M. Goatley Jr., S. C. Hodges, C. Hong, C. S. Johnson, D.B. Langston Jr , J. Latimer, R. O. Maguire, J. M. McDowell, A. Niemiera, M. A. Saghai Maroof, D. G. Schmale III, W. E. Thomason, T. Thompson, B. A. Vinatzer, G. Welbaum, J. H. Westwood, T. Wolf, K. Xia, K. S. Yoder, and C. E. Zipper
Associate Professors: S. D. Askew, M. Balota, J. N. Barney, A. B. Baudoin, E. CollÃ¡kovÃ¡, J. H. Fike, W. H. Frame, J. M. Galbraith, D. Holshouser, J. G. Jelesko, G. Pilot, M.S. Reiter, S. L. Rideout, H. Scoggins, B. F. Tracy, C. A. Wilkinson, M. Williams, and B. Zhao
Assistant Professors: R. Arancibia, B. D. Badgley, M. L. Flessner, T. Fukao, D. C. Haak, S. Li, D. S. McCall, H. L. Mehl, M. O'Rourke, J. Owen, M. Nita, J. Samtani, M. Steele, R. Stewart, X. Wang and B. Zhang
Affiliate Professor: A. Pereira
Adjunct Professors: J. Atland, M. Chaungsheng, K. Da, Y. Dan, B. Flinn, R. F. Follett, Z. Liu, S. Lowman J. E. Perry III, P. J. Thomas, R. W. Tiner, M. J. Vepraskas, and S. Zhang
AP Faculty Professional: D. Close, S. Douglas, J. Freeborn, S. Gugercin, S. Huckestein,

L. Fox, A. Straw, and A. Vallotton
Instructors: M. A. Hansen, A. Hessler, B. Leshyn, and L. Taylor
Special Research Faculty: E. A. Bush, and S. Y. Park

Web: **www.spes.vt.edu**

Overview

Capitalizing on the strengths of three departments in the College of Agriculture and Life Sciences â€" Crop and Soil Environmental Sciences; Horticulture; and Plant Pathology, Physiology, and Weed Science â€" the School of Plant and Environmental Sciences increases the college's capacity to tackle challenges in agriculture and food security, the green industry, plant biology, and the environment. Currently, the School offers three undergraduate degrees and majors in Crop and Soil Sciences (with four options), Environmental Science, Environmental Horticulture, and Landscape Horticulture and Design.

Degree Programs

Crop and Soil Sciences

With the world's population now approaching 7 billion people, and expected to exceed 9 billion within 30 to 40 years, the demand for food is expected to double. Therefore, our ability to sustainably produce plants for food and aesthetic purposes is more crucial now than ever before. In the Crop and Soil Sciences program, students learn the fundamentals of plant science and improvement, and soil and environmental stewardship for feeding the world, protecting the environment, and producing quality turfgrass. The programs offer the rigor, flexibility, and practical knowledge that will help students succeed.

Environmental Science

This program brings the basic sciences to bear on many crucial concerns about the environment. The environments of particular interest are terrestrial and wetland ecosystems and associated land and water resources. Specific concerns include environmental protection, pollution prevention and remediation, land-use planning, waste management, ground- and surface-water quality, reclamation and remediation of disturbed or contaminated sites, and minimizing human impacts on the environment.

Horticulture

Horticulture is plant science that includes the study of plant growth and plant interactions with the environment (soil, air, water) to improve human life through the cultivation of crops and the maintenance of a sustainable environment. Horticulture is unique as a scientific field of study in that it often utilizes artistic expression to aid the design of human landscapes and to restore natural environments. The program covers a range of applied and basic environmental plant science topics, from plant-soil interactions, biotechnology, landscape design, sustainable urban landscaping, urban forestry, crop production, and plant breeding.

Plant Pathology, Physiology, and Weed Science

Program covers areas of plant pathology (nature, biology and control of plant diseases), plant physiology, and weed science (weed biology and control, action of herbicides). No undergraduate majors are offered in these areas, but the department does offer an undergraduate minor in Plant Health Sciences, focused on managing plant health in response to a variety of biotic and abiotic threats. Courses offered under this program are designed to furnish basic knowledge of the nature, diagnosis, and control of plant diseases; identification, biology, and control of weeds; plant metabolism, nutrition, molecular biology, and growth regulation; invasive plant biology; and modern pest management and pesticide usage. The department offers graduate programs leading to M.S. in the life sciences and Ph.D. in plant pathology, plant physiology and weed science. A non-thesis M.S. program in plant protection and pest management is also available (see **Graduate Catalog**).

Majors and Options

Agronomy

Students in this option concentrate on the biology and increasingly complex technology of food, feed, fuel, and fiber production. Graduates typically move into farming or into sales, consulting, and managerial positions that directly and indirectly support agricultural production, a most vital component of the world's economy.

Crop Genetics and Breeding

Producing better quality and higher yielding crops has been a long-standing objective of crop breeders. New techniques of genetic engineering are now being brought to bear on crop improvement. Students in this option learn the newest methods of molecular biology and are well prepared for careers in research and industry.

Environmental Horticulture

Experience the creativity and rewards of the many facets of horticulture. Students can specialize in producing floriculture and nursery plants, growing sustainable fruits and vegetables, landscape design and management, and other areas of plant science.

Environmental Science

The Environmental Science curriculum is multidisciplinary and strongly science and technology oriented. The curriculum prepares graduates for immediate entry into environmental careers as well as for graduate specializations. The U.S. Bureau of Labor Statistics forecasts that employment of environmental scientists and specialists is projected to grow 11 percent from 2014 to 2024, faster than the average for all occupations.

International Agriculture

The world's ever-expanding population must be fed; at the same time, we must be good stewards of the Earth's resources. Many countries have not been able to bring food production and resource conservation into balance. Students in the International Agriculture option are interested in finding simultaneous solutions to these concerns. Employment opportunities exist with various private and public agencies.

Landscape Horticulture and Design

Students learn to design, build, and manage beautiful and functional landscapes using science-based practices that improve the living environment and contribute to environmental sustainability.

Turfgrass Management

Using basic principles of the natural sciences and agricultural technology, turf managers have skills that make them highly employable in golf-course management, athletic and recreational fields, lawn maintenance services, the landscaping industry, and sod production.

Minors

The School offers minors in Crop and Soil Environmental Sciences, Environmental Science, Horticulture, Plant Health Sciences, Turfgrass Management, Viticulture, and Wetland Science. The course requirements for each vary and include a required course (s) plus 15 or 16 more credit hours selected from courses from within and outside the department. Consult the department office (330 Smyth) or website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for more information on a minor.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and

university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Opportunities to Excel

Students with outstanding records can qualify for the Honors Program and graduate "in honors" in crop and soil environmental sciences. Other opportunities for personal and professional growth and for recognition include Agronomy Club, Environmental Student Organization, Horticulture Club, and Turf Club. Membership in Alpha Zeta, Gamma Sigma Delta, Pi Alpha Xi or other honoraries, and several scholarships are also available. Many student participate in internships that are commonly available in the respective disciplines.

Graduate courses and research opportunities lead to M.S. and Ph.D. specializations in the Crop, Soil, and Environmental Sciences, Horticulture, and Plant Pathology and Weed Science. (See the **Graduate Catalog** for more information.)

Undergraduate Course Descriptions (CSES)

2244: AGRICULTURE, GLOBAL FOOD SECURITY AND HEALTH
Agriculture and food security within the larger context of applied agronomy, gender role, cultural and political aspects of food production, food policy, production contraints, and global population growth. Emphasis on gender iniquity and globalized food systems will be made. Service learning experience both local and global to promote career opportunity in international development. (3H,3C)

2434: CROP EVALUATION
Identification of more than 200 crops, weeds, seeds and crop diseases. Seed testing for purity according to the rules of the Association of Official Seed Analysts. Crops graded according to the official USDA grain grading standards. (6L,2C)

2444: AGRONOMIC CROPS
An introduction to crop production in Virginia, presenting basic climatic, crop, and soil characteristics and their relation to cropping systems. Introduces basic mechanical, chemical, and managerial tools of crop production and examines feed quality and seed and forage storage. (3H,3C)

2564: TURFGRASS MANAGEMENT
Growth, development, adaptation, and selection of the major turfgrass species. Principles of establishment, mowing, nutrition, irrigation, cultivation, and pest control of lawns and utility turfs. Co: BIOL 1105. (2H,3L,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3114 (ENSC 3114) (GEOS 3614): SOILS
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant-and earth-science majors. Partially duplicates 3134. Pre: CHEM 1036. Co: 3124. (3H,3C)

3124 (ENSC 3124) (GEOS 3624): SOILS LABORATORY
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134. Co: 3114. (3L,1C)

3134 (ENSC 3134): SOILS IN THE LANDSCAPE
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS. (2H,3L,3C)

3144: SOIL DESCRIPTION AND INTERPRETATION
Describing, classifying, evaluating, and interpreting soil and site properties in the class and field. Local field trips supplement lecture and laboratory studies. Required for students interested in attending soil judging contests. Co: 3124, 3114. (1H,6L,3C)

3304 (GEOG 3304) (GEOS 3304): GEOMORPHOLOGY
Examines the variety of landforms that exist at the earth’s surface. Detailed investigation of major processes operating at the earth’s surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion. Pre: GEOG 1104 or GEOS 1004 or GEOS 2104. (3H,3C)

3444 (HORT 3444): WORLD CROPS AND CROPPING SYSTEMS
An introduction to world crops, their primary regions of production, the factors that determine where they are grown, and their economic importance, and how they are used in the human diet. Describes the various factors that can be managed to improve crop yields. Examines present and potential systems of farming for improved crop production in the major climatic and soil ecosystems of the world. Provides an opportunity to taste foods made in traditional and non-traditional ways from the crops hence from field to fork. Junior standing required. (2H,3L,3C)

3564: GOLF AND SPORTS TURF MANAGEMENT
Principles of turfgrass science and culture required for successful establishment and management of intensely utilized fine golf and sports turf surfaces. Pre: 2564. (3H,3C)

3614 (ENSC 3614): SOIL PHYSICAL AND HYDROLOGICAL PROPERTIES
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance. Pre: (3114, 3124) or (GEOS 3614, GEOS 3624). (3H,3C)

3634 (ENSC 3634): PHYSICS OF POLLUTION
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils. Pre: 3114, PHYS 2205, (MATH 2016 or MATH 2024). (3H,3C)

3644 (ENSC 3644): PLANT MATERIALS FOR ENVIRONMENTAL RESTORATION
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils. Pre: BIOL 1106. Co: 3114. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

4134 (ENSC 4134): SOIL GENESIS AND CLASSIFICATION
Formation of soils across landscapes, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory. Pre: (3114, 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (3H,3C)

4144: PLANT BREEDING AND GENETICS
Genetic variation in plants and its importance in plant breeding, and comparisons of theories and procedures in breeding of self-pollinated versus cross-pollinated plants. (2H,3L,3C)

4164 (BIOL 4164) (ENSC 4164): ENVIRONMENTAL MICROBIOLOGY
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling. Pre: BIOL 2604. (2H,3L,3C)

4174: SOIL EVALUATION AND SAMPLING
Naming, describing, classifying, sampling, and interpreting soil and site properties in the field to assess environmental impacts and suitability under specific land use scenarios. Selecting and evaluating sites of representative soil resources across the landscape using accepted professional protocols, simulating workplace responsibilities and performance. Local and regional field trips and sampling projects provide professional skill development evaluated by practitioners and potential employers. Pre: 3114 or 3144. (2H,3L,3C)

4214: SOIL FERTILITY AND MANAGEMENT
Soil productivity and nutrients required for crop growth; fertilizer sources and nutrient reactions in soil; methods of fertilizer nutrient placement in major tillage systems; and interpretation of soil tests and plant analyses for determining crop nutrient requirements. Pre: 3114 or 3134. (3H,3C)

4314 (ENSC 4314): WATER QUALITY
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies. Pre: (ENSC 3604 or BIOL 4004), (MATH 2015 or MATH 1026), (BIOL 1105 or BIOL 1106), (C HEM 1035 or CHEM 1036). (3H,3C)

4324 (ENSC 4324): WATER QUALITY LABORATORY
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314. Pre: CHEM 1046. Co: 4314, ENSC 4314. (3L,1C)

4334 (FREC 4334): PRINCIPLES AND PRACTICE OF AGROFORESTRY
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects. (3H,3C)

4344: CROP PHYSIOLOGY AND ECOLOGY
Developmental and ecological processes important in cropping situations: seed physiology, root and canopy development, flowering, water stress, energy flow, competition; emphasis on physiological adaptations,

limitations to yield, and yield-optimizing strategies. (3H,3C)

4354: ADVANCED AGRONOMIC CROPS
Survey of major agronomic crops grown in the Eastern US and their production including: corn, soybean, wheat, barley, cotton, peanut, tobacco and alfalfa. Covers impact of environmental conditions and management on crops, resource requirements for productivity, and effects on soil resources. (3H,3C)

4444 (ENSC 4444): MANAGED ECOSYSTEMS, ECOSYSTEM SERVICES, AND SUSTAINABILITY
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior Standing required. Pre: 3114 or 3134. (3H,3C)

4544: FORAGE CROP ECOLOGY
Species adaptation interrelated with soil, climatic, and biotic factors as associated with establishment, production, utilization, and nutritional value of forages. (3H,3C)

4644: LAND-BASED SYSTEMS FOR WASTE TREATMENT
Soils as a medium for waste treatment; potential for environmental degradation from biologicals and chemicals added to soils; development of land-based treatment and utilization systems for solid and liquid wastes; issues and concerns relating to large-scale applications of municipal and industrial wastes to land. (3H,3C)

4734 (CHEM 4734) (ENSC 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: 2114, 3124, CHEM 2514 or CHEM 2535, CHEM 2114, (MATH 2015 or MATH 1026). (3H,3C)

4764 (ENSC 4764): BIOREMEDIATION
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and wastewaters, as well as remediation of industrial waste streams. Pre: BIOL 2604. (3H,3C)

4774 (ENSC 4774): RECLAMATION OF DRASTICALLY DISTURBED LANDS
Remediation, rehabilitation, and revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and material analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage. Pre: 3114 or GEOS 3614 or ENSC 3114 or CSES 3134 or ENSC 3134 or CSES 3304 or GEOG 33 04 or GEOS 3304. (3H,3C)

4854 (ENSC 4854): WETLANDS SOILS AND MITIGATION
Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetlands functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetland soils are mandatory. Pre: (3114, 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (2H,3L,3C)

4864: CAPSTONE: CROP & SOIL SCIENCES
Experiential and discussion-based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan that is defended orally. Review available careers in the crop and soil sciences. Compose and critique resumes and cover letters. CSS majors only. Pre: Senior standing. (3H,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (ENSC)

1015-1016: FOUNDATIONS OF ENVIRONMENTAL SCIENCE
Interrelationships between human activities and the environment; emphasis on biological, chemical, and physical principles that govern the flow of energy, materials, and information among physical, ecological and human systems. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3114 (CSES 3114) (GEOS 3614): SOILS
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant- and earth-science majors. Partially duplicates 3134. Junior standing. Pre: CHEM 1036. Co: 3124. (3H,3C)

3124 (CSES 3124) (GEOS 3624): SOILS LABORATORY
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134. Co: 3114. (3L,1C)

3134 (CSES 3134): SOILS IN THE LANDSCAPE
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS. (2H,3L,3C)

3604: FUNDAMENTALS OF ENVIRONMENTAL SCIENCE
Interrelationships between human activities and the environment; provides national and global perspective; emphasis is on the physical, chemical, and biological principles and processes that are essential to an understanding of human-environment interactions; the role of energy in human and natural systems; environmental legislation and human behavior. Pre: BIOL 1105 or CHEM 1035. (3H,3C)

3614 (CSES 3614): SOIL PHYSICAL AND HYDROLOGICAL PROPERTIES
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance. Pre: (CSES 3114, CSES 3124) or (GEOS 3614, GEOS 3624). (3H,3C)

3634 (CSES 3634): PHYSICS OF POLLUTION
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources

of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils. Pre: CSES 3114, PHYS 2206, (MATH 2016 or MATH 2024). (3H,3C)

3644 (CSES 3644): PLANT MATERIALS FOR ENVIRONMENTAL RESTORATION
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils. Pre: BIOL 1106. Co: CSES 3114. (3H,3C)

4134 (CSES 4134): SOIL GENESIS AND CLASSIFICATION
Formation of soils across landscape, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory. Pre: (CSES 3114, CSES 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (3H,3C)

4164 (BIOL 4164) (CSES 4164): ENVIRONMENTAL MICROBIOLOGY
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling. Pre: BIOL 2604. (2H,3L,3C)

4314 (CSES 4314): WATER QUALITY
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies. (3H,3C)

4324 (CSES 4324): WATER QUALITY LABORATORY
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314. Pre: CHEM 1046. Co: CSES 4314, 4314. (3L,1C)

4414: MONITORING AND ANALYSIS OF THE ENVIRONMENT
Provides comprehensive hands-on-laboratory-and field-based experience and information on the principles and methods for field monitoring and sampling, as well the physical, chemical, and biological analysis of soil, surface water, groundwater, and solid wastes within the context of regulatory compliance. Optional 40-hour Hazards Materials (HAZMAT) training will be available. Senior standing required. Pre: (3604 or 4314 or CSES 4314 or BIOL 4004), (MATH 1026 or MATH 2015, CHEM 1036, BIOL 1105). (1H,3L,2C)

4444 (CSES 4444): MANAGED ECOSYSTEMS, ECOSYSTEM SERVICES, AND SUSTAINABILITY
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior or Senior Standing required. Pre: CSES 3114 or CSES 3134. (3H,3C)

4734 (CHEM 4734) (CSES 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: CSES 3114, CSES 3124, CHEM 2514 or CHEM 2535, CHEM 3114, (MATH 2015 or MATH 1026). (3H,3C)

4764 (CSES 4764): BIOREMEDIATION
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and

wastewaters, as well as remediation of industrial waste streams. Pre: BIOL 2604. (3H,3C)

4774 (CSES 4774): RECLAMATION OF DRASTICALLY DISTURBED LANDS
Remediation, rehabilitation, revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and materials analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage. Pre: CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134 or CSES 3304 or GE OG 3304 or GEOS 3304. (3H,3C)

4854 (CSES 4854): WETLAND SOILS AND MITIGATION
Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetland functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetlands soils are mandatory. Pre: (CSES 3114, CSES 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CS ES 3134 or ENSC 3134. (2H,3L,3C)

4864: CAPTSTONE: ENV SCIENCE
Discussion based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan. The work plan will demonstrate the student's understanding of contaminant fate and mobility in different environmental media and will be defended orally. Review and explore available careers in environmental science through seminars and working groups within environmental professionals discussing the role and responsibilities of environmental scientists in industry, consulting, regulatory agencies, and non-profits. ENSC majors only. Senior Standing. Pre: (CSES 3634 or ENSC 3634), (ENSC 4414), (CHEM 4734 or CSES 4734 or ENSC 4734), (C SES 4854 or ENSC 4854). (3L,1C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (HORT)

2134 (FREC 2134): PLANTS AND GREENSPACES IN URBAN COMMUNITIES
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales. (3H,3C)

2144: INDOOR PLANTS
Basic horticultural principles, identification and cultural criteria applicable to foliage and flowering plants grown indoors. Specific plant groups discussed include ferns, cacti and succulents, and carnivorous plants, among many others. Non-majors only. (3H,3C)

2154 (SPAN 2154): SPANISH FOR THE GREEN INDUSTRY
Dialogue-based language course focusing on the vocabulary and grammatical structures pertaining to Green and Agricultural Industry jobs. Includes vocabulary and context specific to jobs and workers in greenhouse, nursery, turf and landscape environments. Spanish culture is included throughout the course along with grammar and structure. Prior study in Spanish is helpful but not required. I, II. (3H,3C)

2164: FLORAL DESIGN
Principles and methods in floral art through designs for home and public environments. (2H,3L,3C)

2184: PLANTS, PLACES, AND CULTURES IN A GLOBAL CONTEXT
Impact of worldwide production and trade in fruits, vegetables, and cut flowers (horticultural commodities) on societies, cultures, economies, politics, and environment. Case studies covering history, economics, social/cultural impacts of producing fruit, vegetables, tea, coffee, and other horticultural crops in producing and consuming countries. Case studies illustrate inextricable interactions and interconnectedness between horticultural crops and cultures. (3H,3C)

2224: HORTICULTURE SCIENCE AND INDUSTRY
Survey course of horticultural crops (fruits, vegetables, ornamentals) and enterprises. Includes plant science and business aspects of horticultural production and service industries, and introduces related issues and emerging technologies such as work force characteristics, organic production, and biotechnology. I. (2H,2C)

2234: ENVIRONMENTAL FACTORS IN HORTICULTURE
Principles and practices in managing environmental factors - temperature, water, light, atmospheric gases and pollutants, and soil and minerals - that influence growth and production of horticultural plants. (3H,3C)

2244: PLANT PROPAGATION
Principles and practices of plant propagation by sexual and asexual methods. (2H,2L,3C)

2304 (BIOL 2304): PLANT BIOLOGY
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants. Pre: BIOL 1105, BIOL 1106. (3H,3C)

2554 (FREC 2254): ARBORICULTURE FIELD SKILLS
Field observation, discussion, and practice of skills employed in the management of urban landscape trees. Hands-on experience with tree pruning, removal, pest control, fertilization, cabling/bracing, lightning protection, and climbing. Emphasis on arborist safety, professional ethics, and best management practices. Guest instruction provided in part by professionals working in the tree care industry. Pass/Fail only. (3L,1C)

2834: SUSTAINABLE AGRICULTURE PRACTICUM
Hands-on training in sustainable agricultural production at a student-operated vegetable and fruit farm. Participation in tasks required in managing a diversified sustainable horticulture operation, including planting, pest management, irrigation, and post-harvest handling. Discussion of soil fertility, planning, efficiency, food safety and community food systems. May be repeated with different content, for a maximum of 6 credits. (1H,6L,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3114 (FST 3114): WINES AND VINES
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age. (3H,3C)

3325-3326: WOODY LANDSCAPE PLANTS
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants. (2H,3L,3C)

3345,3346: HERBACEOUS LANDSCAPE PLANTS

Identification, growing requirements, culture, landscape use, flowering and dormancy physiology, and unique propagation of native and non-native herbaceous plants for temperate environments. 3345: Summer and fall-flowering ornamental annuals and perennials; cultivated wildflower, wetland, and aquatic systems. 3346: Winter and spring-flowering species and related herbaceous foliage plants. Junior standing required. Pre: 2244. (1H,3L,2C)

3354 (FREC 3354): URBAN FORESTRY AND ARBORICULTURE
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment. Pre: (FOR 2314 or FREC 2314 or BIOL 2304 or HORT 2304), (FOR 2324 or FREC 2324 or HOR T 3325 or HORT 3326). (3H,3C)

3444 (CSES 3444): WORLD CROPS AND SYSTEMS
An introduction to world crops, their primary regions of production, the factors that determine where they are grown, and their economic importance, and how they are used in the human diet. Describes the various factors that can be managed to improve crop yields. Examines present and potential systems of farming for improved crop production in the major climatic and soil ecosystems of the world. Provides an opportunity to taste foods made in traditional and non-traditional ways from the crops hence from field to fork. Junior standing required. (2H,3L,3C)

3454: HERBACEOUS PLANTS FOR ECOLOGICAL LANDSCAPES
Plant selection to provide ecosystem services. Site analysis, design, preparation, planting and maintenance strategies specific to cold-hardy herbaceous plants including native and non-native perennials, and ornamental grasses. Philosophy, historical perspective, and case studies of ecological planting designs. Pre: 2234 or BIOL 1105. (3H,3C)

3544: LANDSCAPE CONSTRUCTION
Survey of landscape construction materials and methods. Concentration on small scale and residential applications, innovative uses, and cost estimates. (1H,3L,2C)

3584: LANDSCAPE CONTRACTING PRACTICUM
The development of practical skills in landscape contracting. The course will rotate between design and installation of water gardens, landscape irrigation systems, landscape lighting or other pertinent topics on consecutive years. The course can be repeated for exposure to specific subjects to maximum of 3 credits. Junior standing required. Pass/Fail only. Pre: 2224, 2234. (3L,1C)

3664: HARDSCAPE MATERIALS AND INSTALLATION
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction methods, and business aspects required for hardscape construction. Pre: 2224. (6L,2C)

4004: HORTICULTURE SEMINAR
Assessment of fundamental horticultural skills developed through academics and employment. Includes career placement preparation and problem solving through research and production project design and implementation using a team approach. Junior standing required. (1H,1C)

4064: SOIL MICROBIOLOGY
Soil microbes as determinants of plant growth, sustainable agricultural systems, and global nutrient cycles. Environmental controls of soil microbes and relationship to soil decomposition. Soil as a micro-habitat. Application to soil management and plant growth, plant-microbe mutualisms, probiotics, biocontrol, composting, ecosystem restoration, and disease suppression. Pre: BIOL 1105, (CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134). (3H,3C)

4205,4206: PUBLIC GARDENS MAINTENANCE AND MANAGEMENT
4205: Principles and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management;

information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/accessions curation and database management; personnel and financial management issues unique to public gardens. Pre: Junior standing required. (3L,1C)

4324: GREENHOUSE MANAGEMENT
For persons who intend to manage or advise those managing commercial or institutional greenhouses. Includes greenhouse construction, environmenal controls, disease/insect identification and management, control of plant growth, root-zone management, and marketing and management principles specific to greenhouse operations. Pre: Coursework or experience in plant growth and environmental management required. (3H,3C)

4504: LANDSCAPE CONTRACTING
Capstone course for students entering the landscape contracting industry. Includes contracts, site plan interpretation, cost estimation and bidding, project sequencing, business marketing, irrigation design, and current issues. Emphasis on real-world skills and problem solving. Pre: Senior Standing Required. Pre: 3264, 4004. (1H,3L,2C)

4545-4546: SMALL SCALE AND RESIDENTIAL LANDSCAPE DESIGN Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction. Pre: 3325, 3544 for 4545; 3325, 3544, 4545, 4545 for 4546. (2H,6L,4C)

4554 (BSE 4554) (FREC 4554) (LAR 4554) (SPIA 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: 2134 or FREC 2134. (3H,3C)

4614: ORNAMENTAL PLANT PRODUCTION AND MARKETING
In-depth production and marketing of woody and herbaceous plants in wholesale nursery and floriculture/greenhouse and related retail outlets. Includes production laboratory. Pre: 2234, 2244, 4324, AAEC 2434. (2H,3L,3C)

4644: SMALL FRUIT PRODUCTION
Propagation, production, and marketing of small fruit crops for the mid-Atlantic region. Emphasis on sustainable practices, market sectors, and health and nutritional benefits. Blueberries, strawberries, brambles and other crops. Pre: 2234, 2244, AAEC 2434. (3H,3C)

4654: VITICULTURE
Overview of grapevine growth and development, factors affecting yield and grape quality, and regional industry. Vineyard financial considerations, site evaluation, varietal characteristics plus cultural practices of pruning, training, canopy management, fertilization and pest management. Pre: 2234. (3H,3C)

4744: PLANT ESTABLISHMENT AND ENVIRONMENTAL DESIGN
Plant establishment and environmental design process for sustainable landscapes emphasizing the relationship between design of human-constructed landscapes and ecosystems at larger scales. Site assessment, urban soils, site rehabilitation, plant response to disturbed environments, green infrastructure and other contemporary landscape forms. Plant selection, sourcing, and installation to achieve environmental design goals. Emphasis on hands-on, experiential learning to achieve sustainable landscapes. Pre: Senior Standing. Pre: 2134 or FREC 2134 or CSES 3134 or ENSC 3134 or CSES 3114 or ENSC 3114 or GEOS 3614 or LAR 1254. (2H,3L,3C)

4764: VEGETABLE CROPS
A comprehensive study of major and minor vegetable crops of Virginia, the U.S., and world in relation to production practices, crop development, nutritional value, and quality characteristics. Pre: 2234. (3H,3C)

4784: VEGETABLE SEED PRODUCTION

The study of production agriculture or reproductive biology. Seed production, handling, identification, conditioning, enhancement, packaging, storage, testing, federal standards, and biotechnology. Pre: 4764 or 2244 or equivalent experience in vegetable crops, plant propagation, or plant growth and development. Pre: 4764 or 2244. (2H,2C)

4794: MEDICINAL PLANTS AND HERBS
Comprehensive study of medicinal plants/herbs history, production, processing, lore and documented scientific benefits. Traditional plant medicinal practices of Native Americans, Chinese, Indians, European and African cultures will be contrasted with use of contemporary herbal products. Pre: BIOL 1005 or BIOL 1105. (3H,3C)

4835-4836: ORGANIC VEGETABLE PRODUCTION
Detailed practices in organic vegetable production. Issues in starting organic production, profitability, organic transition strategies and organic certification. Pre: 2254, ALS 3404 for 4835; 4835 for 4836. (2H,2C)

4845-4846: ORGANIC VEGETABLE PRODUCTION LABORATORY
Field experiences, demonstrations, and farm tours complementing 4835 and 4836 lectures. Co: 4835 for 4845; 4836 for 4846. (3L,1C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Undergraduate Course Descriptions (PPWS)

2004: MYSTERIOUS MUSHROOMS, MALICIOUS MOLDS
Study of the fungi and their close relatives, with special attention to their roles in the natural world and in shaping the course of human history. Historical and practical significance of fungi as sources of medicine, pathogens of plants and animals, rotters and decayers of organic matter, makers of food and drink, manufacturers of dangerous toxins, and producers of mind-altering chemicals. A student must have a basic understanding of biology. (3H,3C)

2104: PLANTS, GENES, AND PEOPLE
Explores how and why humans have manipulated plant genomes from prehistory through the current genomic era by examining the scientific, cultural, historical, and legal aspects of plant gene management in both conventional and transgenic crops. Pre: BIOL 1005 or BIOL 1105. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3504: PLANT PHYSIOLOGY AND THE BIOTIC ENVIRONMENT
Course explores how both agricultural and non-crop plants grow, develop, and respond to biotic environmental influences. Topics include symbiotic and pathogenic microorganisms, herbivores, phytoremediation, parasitic plants, and weeds. The scope ranges from biochemical, cellular, tissue, to whole plant physiology. Course includes an experimental project in plant physiology on one of the topics. Pre: (BIOL 1006 or BIOL 2304),

CHEM 1036. (3H,3C)

3514: PLANT PHYSIOLOGY LAB
A laboratory course designed to illustrate basic physiological principles related to nutrient deficiencies, membrane permeability and composition, water/nutrient absorption and translocation, transpiration, photosynthesis, physiological functions of growth regulators, enzyme activity, and elemental composition of plant tissue. Course requirements may be satisfied by taking PPWS 3504 or CSES 4344 prior to or concurrent with this course. (3L,1C)

3754: WEEDS THAT SHAPE OUR WORLD
Introduction to weed management methods, weed characteristics- chemistry, morphology and reproduction, and the economic and social factors that both drive and limit efforts to control plant populations. Identification of weed species. Pre: (BIOL 1005 or BIOL 1105 or BIOL 1205H), (BIOL 1006 or BIOL 1106 or BIOL 1206H). (3H,3C)

4104: PLANT PATHOLOGY
Introduction to plant pathology as a science and a crop protection discipline. Plant disease diagnosis, biology, and identification of plant disease-causing agents, factors leading to disease build-up, and management of plant diseases. Diseases of specific crops are studied as examples to illustrate general principles. Pre: (BIOL 1005 or BIOL 1105), (BIOL 1006 or BIOL 1106). (3H,3L,4C)

4114: MICROBIAL FORENSICS AND BIOSECURITY
Concepts of comparative and evolutionary genomics for pathogen characterization and identification taught through case studies of bioterrorism, involuntary and voluntary disease transmission, infectious disease epidemics, and genetically modified organisms; emphasis placed on unambiguous source attribution of a disease outbreak to a particular microbe, risk assessment, response as individual, community, and nation to a bioterrorism attack or disease outbreak, federal biosecurity regulations, and career opportunities. Pre: BIOL 2604, (BIOL 2104 or BIOL 2004). (3H,3C)

4154: PLANT PROBLEM DIAGNOSIS
Plant problem diagnosis in the laboratory and field, including recognition of disease, insect and abiotic (nonliving) problems, as well as the major groups of plant pathogens of a variety of regionally important horticultural and agronomic crops. General management options for pests and pathogens. Co: 4104. (2H,3L,3C)

4264 (ENT 4264): PESTICIDE USAGE
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides. Pre: CHEM 2515 or CHEM 2536. (2H,3L,3C)

4504: FUNDAMENTALS OF PLANT PHYSIOLOGY
Fundamental principles of plant physiology (photosynthesis, respiration, transpiration, nutrition, translocation, and development) will be integrated with discussion of the relationship between abiotic environmental factors and plant physiological processes. Both agricultural and non-crop plants will be emphasized. Pre: (BIOL 1006 or BIOL 2304), CHEM 1036. (3H,3C)

4604: BIOLOGICAL INVASIONS
Broad overview of the causes, consequences, and epidemiology of invasive plants, animals, and microbes. Conceptual, mechanistic, societal, and political components of invasive species from Darwin to modern day, covering the invasion process from introduction to ecological or economic impact. Taxonomy, management, and risk assessment will be covered via case studies, within a policy context. Pre: BIOL 1105, BIOL 1106. (2H,3L,3C)

4754: WEED SCIENCE: PRINCIPLES AND PRACTICES
Weeds and human affairs; costs and losses; emphasis on weed biology, weed identification and weed-crop ecology; agronomic, physiological, and chemical principles underlying prevention, eradication, and control of undesired vegetation; methods of weed control available for modern agronomic, forestry, horticultural, and

non-crop situations. Pre: BIOL 2304, CHEM 1036. (2H,3L,3C)

4964: FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

School of Public and International Affairs

Undergraduate Program Director: Ralph Hall
University Distinguished Professor: P. Knox
Professors: T. Sanchez, and M. Stephenson
Associate Professors: D. Bieri, M. Cowell, R. Buehler, R. Hall, S. Misra, K. Wernstedt, D. Zahm, and Y. Zhang
Assistant Professors: T. Lim, T. Schenk, T. Skuzinski, and W. Zhang.
Adjunct Professors: B. Anderson, S. Mastran, E. Morton, J. Provo, and M. E. Ridenour

Web: **https://www.spia.vt.edu/undergrad/**

Overview

The School of Public and International Affairs (SPIA) provides opportunities for students interested in public issues to gain perspectives and skills from several related disciplines. SPIA is a school within the College of Architecture and Urban Studies, and is comprised of the Center for Public Administration and Policy, the Government and International Affairs Program, the Urban Affairs and Planning Program, and the SPIA Undergraduate Program that offers a B.A. in Public and Urban Affairs (PUA) and two majors in Smart and Sustainable Cities (SSC) and Environmental Policy and Planning (EPP).

SPIA also provides a Washington, D.C. Semester in Global Engagement (during the Spring and Fall semesters) and a Washington, D.C. Semester in Leadership through Policy and Governance (during the summer session). Information on the SPIA Undergraduate Program can be obtained from the SPIA website.

Information on graduate programs may be obtained from the Center for Public Administration and Policy, Government and International Affairs, and Urban Affairs and Planning.

B.A. in Public and Urban Affairs

Smart and Sustainable Cities Major (SSC)

The Smart and Sustainable Cities (SSC) major is one of the first majors of its kind in the United States. In the major, students will learn the dynamics of urban change across time, space, and place. Students will gain a deep understanding of sustainable urban development and how smart technology and urban analytics can be combined to create solutions for the cities of the future.

The core of the major consists of two parallel tracks. The first track focuses on urban analytics and decision-making. In this track, students will develop modeling and data visualization skills that can be applied to understand urban and regional systems in data-driven, quantitative, and computational ways.

The second track focuses on sustainable urbanization and the future of cities. Students in this track will study the process of urbanization. Specific attention given to the interdependence of social, economic, environmental and technological factors and how these evolve over time.

Both of these tracks are then integrated through a course on data and the art of decision-making and a fusion studio where students will apply their knowledge to real problems.

Environmental Policy and Planning Major (EPP)

Promoting sustainable human interaction with the natural environment continues to be one of the critical challenges facing societies around the world. While science and technology are critical to meeting this challenge, they must be supported by policies and plans responsive to diverse political, economic, sociocultural, institutional, and regulatory contexts.

The Environmental Policy and Planning (EPP) major provides students with an interdisciplinary framework to view environmental problems. Students will obtain the knowledge and skills needed to function as policymakers and planners who can understand complex environmental issues and develop enduring solutions.

The EPP major builds on the Public and Urban Affairs (PUA) degree core that provides students with foundational knowledge in policy, planning, governance, and international affairs. The EPP major extends this knowledge through an interconnected sequence of courses that explore environmental policy and planning, land use, and environmental law. EPP students will also develop their expertise by selecting one more elective from three subject areas: Policy; Planning; and Environment and Conservation.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Urban Affairs and Planning.

Satisfactory progress requirements toward the B.A. in Public and Urban Affairs can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (SPIA)

1024: COMMUNITY SERVICE LEARNING
An introduction to community service learning with emphasis on the development of civic agency. Critical perspectives on community, ethical community engagement, service and volunteerism, servant leadership, and social change. Exposure to the socio-political dynamics inherent in community development and problem solving. Includes significant community engagement and service-learning experiences, reflection, and the development of a personal community engagement action plan. (3H,3C)

2005,2006: INTRODUCTION TO URBAN ANALYTICS SPIA
2005: Introduction to modeling, simulation, and visualization. How models can be used to examine complex urban problems. Ethical issues in the application of computational models. Basic model building without data. SPIA 2006: Identifying data sources for simulation model building and testing. Developing and using a model to understand a complex urban problem. Manipulating models to achieve desired outcomes. Ethical issues in computational models, including data collection and data use. (1H,1C)

2024: COMMUNITY SYSTEMS THINKING
Introduction to systems thinking concepts and their application to community-based problem solving and decision making. Emphasis on identifying interactions between technical and contextual dimensions of persistent, complex global problems. Introduces systemic frameworks for defining problems, identifying and engaging stakeholders, ideating interventions, selecting and employing criteria for decision making, and creating feedback mechanisms for iterative design. Ethics of community engagement is considered. Includes problem- based service-learning projects. (3H,3C)

2104: URBAN ANALYTICS FOR DECISION-MAKING
Use and critique of large-scale computational models for urban planning and decision-making. Information synthesis, agent-based simulation, and simulation analytics techniques for analysis of urban and regional systems. Value-sensitive design and ethical use of computational models. (1H,1C)

2114: PUBLIC SERVICE LEADERSHIP
Definition and practice of leadership in the public and nonprofit sectors, and its relationship to democratic governance. Decision-making under varying degrees of certainty and ambiguity. Exploring the relationship between public values and the public interest. Evidence for decisions. Case study engagement and presentation. (1H,1C)

2244 (GEOG 2244): SUSTAINABLE URBANIZATION
Process of urbanization and theories and approaches of urban development. Debates on the meanings of sustainable urbanization and development in cities and how they are measured. Urban sustainability initiatives in the context of urban political economies, land-use practices, urban inequality and diversity, urban nature, and urban policy and politics. Programs and policies designed to enhance sustainable urbanization. Comparative approach and global perspective. (3H,3C)

2314 (HNFE 2314): ACTIVE TRANSPORTATION FOR A HEALTHY, SUSTAINABLE PLANET
Connections among active transportation (e.g., bicycling, walking) and significant global challenges such as physical inactivity, health, the environment, and the economy on local to global scales. Methods to assess walkability among communities with different worldviews and the influence of the built environment on rates of active transportation. Approaches to evaluate demographic and psychosocial predictors and physical and policy barriers to use of active transportation. Successful strategies to increase active transportation through community design guidelines, behavior change tools, transportation planning, and policy. (3H,3C)

2554: COLLABORATIVE POLICY-MAKING & PLANNING
Introduction to multi-stakeholder collaboration and public participation in planning, policy-making and public administration. Tools and approaches for engagement and effective collaboration. Deliberative and participatory democracy, and transparency in society. Information sharing and access. Civil society, the media and citizen activism. Ethical and moral issues in collaboration. Barriers to participation, and diversity and inclusion. (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

3554: TRANSDISCIPLINARY PROBLEM SOLVING FOR SOCIAL ISSUES
Strategies and skills for transdisciplinary problem solving. Emphasis on integrative thinking strategies and cognitive and interpersonal skills required to bridge scientific discipline-based, non-scientific discipline-based and cultural knowledge. Strategies to identify important disciplinary, non-scientific, ethical, cultural, and structural elements of a problem. Problem-based learning, ethics, team work, and effective communication skills. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4374: FEDERAL CYBERSECURITY POLICY AND REGULATION
This course seeks to give students an understanding of how the government develops new cybersecurity regulations and policies that balance consumer interest in personal protection with industry attitudes towards oversight. The course also covers the policies that government entities take in the interest of national security to maintain state secrets in the face of threats from hackers and other hostile actors. Pre: FIN 4014. (3H,3C)

4454: FUTURE OF CITIES
Cities as complex systems. Interdependence of social, economic, environmental, and technological components and how these change over time. Theories about city formation, structure, and change, with implications for sustainability, resilience, and globalization. Pre: GEOG 2244 or SPIA 2244. (3H,3C)

4464: DATA AND THE ART OF POLICY-MAKING AND PLANNING
Critical examination of use of scientific and technical information in planning and policy-making, exploring issues and challenges through social science lens. Investigation of appropriate and responsible use of data within collaborative and deliberative policy-making and planning processes. Presentation of data and underlying models in accessible and understandable formats. Integrating all forms of knowledge into decision-making, including local and traditional knowledge. (3H,3C)

4554 (BSE 4554) (FREC 4554) (HORT 4554) (LAR 4554): CREATING THE ECOLOGICAL CITY
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing. Pre: HORT 2134 or FREC 2134. (3H,3C)

4724: CYBERLEADERS CAPSTONE
Interdisciplinary research and analysis from technical and policy standpoints of regulation and industry standards, leading to the development and communication of possible solutions for specific cybersecurity problems related to critical systems. Previous topics include cellphone encryption and Internet of Things security. Co: 4374. (2H,12L,6C)

4784: COMMUNITY SYSTEMS CAPSTONE
Collaborative community problem solving in team environments Data collection, interpretation, and presentation augment community-based, iterative design and planning processes. Consideration of ethical engagement and community goals related to social justice, resilience, and sustainability. Discourse-based

project culminating in presentation of intervention proposals to stakeholders. Pre: 3 credits in Discourse. Pre: (1024 or SOC 2034), SPIA 2024. (3H,3C)

4964: FIELD WORK/PRACTICUM
Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
Variable credit course.

Undergraduate Course Descriptions (UAP)

1004: INTRODUCTION TO CAREERS IN URBAN AFFAIRS AND PLANNING
Introduces academic requirements for the Public and Urban Affairs (PUA) and Environmental Policy and Planning (EPP) majors. Assists students with academic planning and career exploration. Students develop an ePortfolio to document their personal and professional growth in the major. Course must be taken during the first semester in the PUA or EPP program. (1H,1C)

1024: PUBLIC ISSUES IN AN URBAN SOCIETY
This class introduces some of the most vital concerns and issues challenging democratic capitalistic urban societies today. Topics addressed include different perspectives on the causes and portent of the urban underclass, the growing inequality between the educated and less well educated in the nation's labor markets, the causes of the marked resegregation of many of the nation's urban centers by race and income and the implications of privatization and interjurisdictional competition for the public policy behavior and outcomes of subnational governments. (3H,3C)

2004 (REAL 2004): PRINCIPLES OF REAL ESTATE
Introduction to real estate, including markets, land use planning and zoning, development, finance, construction, sales, marketing, management and property valuation. Examines the key actors and processes in each of these areas. Explores major public policies impacting real estate. (3H,3C)

2014: URBANIZATION AND DEVELOPMENT
Relationships between urbanization and economic development; role of cities in social, political, cultural, and economic development of societies; cities as settings for innovation and change. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3014: URBAN POLICY AND PLANNING
An introduction to urban policy and urban planning. Includes analysis of the basic concepts and principles of urban policy, a review of urban policy in the United States, discussion of the development of urban planning and its role in shaping the urban environment, and an analysis of the relationship between public policy and planning and the organization and structure of the urban environment. Pre: 1024. (3H,3C)

3024: URBAN AND REGIONAL ANALYSIS
Overview and application of various methods used to study, represent, understand communities in their urban and regional context. Data collection and analysis; population, land use, transportation and economic forecasting; selecting and applying an appropriate method; designing and presenting a community study. Restricted to majors and minors only. (3H,3C)

3224: POLICY IMPLEMENTATION
Systematic analysis of the field and practice of public policy implementation. Includes analysis of the structure and dynamics of the policy process as well as specific analytic approaches to understanding policy implementation. Includes analysis of intra-organizational, interorganizational and intergovernmental implementation processes. Pre: 3014, STAT 3604. (3H,3C)

3264: CONTEMPORARY URBAN ISSUES
Consideration of one particular issue of immediate importance to the contemporary urban environment. Topics emphasize major social or economic policy issues, and may change each year. Junior standing required. (3H,3C)

3344 (PSCI 3344): GLOBAL ENVIRONMENTAL ISSUES: INTERDISCIPLINARY PERSPECTIVES
Critical examination of major global environmental problems (e.g., global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste) with emphasis on their social, economic, political, ethical, and policy implications and solutions. Completion of Area 4 of University Core required. (3H,3C)

3354: INTRODUCTION TO ENVIRONMENTAL POLICY AND PLANNING
Introduction to the interdisciplinary principles of environmental policy, planning, economics, and ethics to address pollution abatement, resources conservation, habitat protection, and environmental restoration. The course will focus on practical means of identifying environmental problems and creatively solving them. (3H,3C)

3434 (PSCI 3414): PUBLIC ADMINISTRATION
The role and context of public administration in the contemporary United States, administrative organization and decision-making, public finance, human resources administration, and program implementation. Pre: PSCI 1014. (3H,3C)

3444 (PSCI 3444): ADMINISTRATIVE LAW AND POLICY
The legal context of the exercise of discretion by public administrators in the United States. Adjudication and rule- making; access to administrative processes and information; legislative and judicial control of administration. Pre: PSCI 1014. (3H,3C)

3464 (AHRM 3464) (APS 3464) (GEOG 3464) (HD 3464) (HUM 3464) (SOC 3464): APPALACHIAN COMMUNITIES
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing. (3H,3C)

3714 (PSCI 3714): THE U. S. POLICY PROCESS
Description and analysis of the processes and institutions involved in the making and implementation of public policy in the United States, with a primary focus on domestic and economic policy. Empirical and normative models of the process of public policy making in the U.S. Pre: PSCI 1014. (3H,3C)

3744 (PSCI 3744): PUBLIC POLICY ANALYSIS
Methods and approaches used in the analysis and evaluation of public policy; strengths and limitations of various analytic tools; normative issues in the practice of policy analysis. Pre: PSCI 1014 or PSCI 1014H. (3H,3C)

3774 (PSCI 3774): MARXIAN POLITICAL ANALYSIS
Contemporary uses of Marxian concepts and theories to study the world economy, business structure, current social issues, modern ethical values, and alienation. Pre: PSCI 1014 or PSCI 1014H. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984: SPECIAL STUDY
Variable credit course.

4184: COMMUNITY INVOLVEMENT
Issues, concepts, and techniques of citizen participation in community development. Institutional frameworks and their historical precedents. Exercises developing group communications skills, public meeting facilitation, and design of community involvement programs. Pre: Senior standing required. (3H,3C)

4214 (GEOG 4214) (WGS 4214): GENDER, ENVIRONMENT, AND INTERNATIONAL DEVELOPMENT
Key concepts and critiques related to the intersection of gender, environment, and international development.

Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing. (3H,3C)

4264: ENVIRONMENTAL ETHICS AND POLICY
Issues in applied environmental ethics. Contributions of diverse religious and philosophical traditions to contemporary perspectives on the human-nature relationship. Examination of environmental policies from utilitarian economic, deep ecology, and ecofeminist perspectives. Junior, senior or graduate standing required. (3H,3C)

4344: LAW OF CRITICAL ENVIRONMENTAL AREAS
This course examines the legal principles and policy debates involved in the regulation and protection of critical environmental resources. Specific topics vary but will likely include wetlands law and policy, endangered species habitat, open space, forestland and farmland protection, coastal zone management, and floodplain regulation and policy. (3H,3C)

4354: INTERDISCIPLINARY ENVIRONMENTAL PROBLEM SOLVING STUDIO
Interdisciplinary, experiential problem solving studio focusing on specific environmental problems. Working in groups, students interact with local officials, consultants, developers, environmental groups to explore the processes of environmental management, regulation and mitigation, applying techniques and skills frequently used by environmental planners and policy-makers. Senior status required and 9 credit hours, 3000-level or above, in the Environmental Policy and Planning major or minor; Pre: 3354, 3224. (2H,5L,4C)

4364: SEMINAR IN ENVIRONMENTAL POLICY AND PLANNING
Critical examination of the social, political, economic, legal, scientific, and technological contexts underlying processes of environmental change, problems, and solutions, as seen from various conceptual and disciplinary perspectives. Senior status required and 9 credit hours, 3000-level or above, in the Environmental Policy and Planning major or minor. Pre: 3354, 3224. (2H,2C)

4374: LAND USE AND ENVIRONMENT: PLANNING AND POLICY
Environmental factors involved in land use planning and development, including topography, soils, geologic hazards, flooding and stormwater management, ecological features, and visual quality. Techniques used in conducting environmental land inventories and land suitability analyses. Policies and programs to protect environmental quality in land use planning and development. Pre: Junior standing. (3H,3C)

4384: POLLUTION CONTROL PLANNING AND POLICY
Planning and policy aspects of managing residuals and environmental contaminants and their effects on human health and environmental quality. Technical and economic factors involved in management of water quality, air quality, solid and hazardous wastes, toxic substances, and noise. Implementation of pollution control legislation, policies, and programs at federal, state, and local levels. (3H,3C)

4394: COMMUNITY RENEWABLE ENERGY SYSTEMS
Practical design fundamentals for small scale renewable energy systems: solar building heating and cooling; solar domestic hot water; wind, photovoltaic, and hydroelectric systems; alcohol, methane and other biomass conversion systems. Developing plans, programs, and policies to stimulate development of renewable systems. Pre: (MATH 1016 or MATH 1025). (3H,3C)

4624 (PSCI 4624): THE WASHINGTON SEMESTER: SEMINAR IN AMERICAN POLITICS AND PUBLIC POLICY
This seminar is the integrative forum for the principal elements of the Washington Semester experience. The course explores both the role of political institutions in policy formation and implementation and the primary managerial and leadership challenges that arise for implementing organization managers in American democratic public policy-making. Pre: Junior standing or instructor consent and acceptance into the Washington Semester program. X-grade allowed. (3H,3C)

4644 (PSCI 4644): THE WASHINGTON SEMESTER: POLITICS, POLICY AND ADMINISTRATION IN A DEMOCRACY

This course is part of the Washington Semester. Explores the relationship between the imperatives of democratic mobilization, policy choices and organizational choices through intensive study of the operating context of a selected public or nonprofit organization. Examines implications of policy-maker choices for implementing institution dynamics and challenges. Pre: Junior standing and acceptance into the Washington Semester program required. X-grade allowed. Pre: PSCI 3714. (3H,3C)

4714: ECONOMICS AND FINANCING OF STATE AND LOCAL GOVERNMENTS
Examines the provision and financing of public goods and services in local governments. Analyzes associated policy issues. Reviews experience in Western Europe and developing countries, as well as in the United States. Pre: 3024, (ECON 2005 or ECON 2005H), (ECON 2006 or ECON 2006H). (3H,3C)

4754: LEGAL FOUNDATIONS OF PLANNING
Examination of the legal context in which urban planning and public policy operate. Legal structure, role of law, powers of sovereign governments, constitutional limitations on government activities, and public-private conflict and their influence on planning and public policy are examined. Pre: Junior standing required. (3H,3C)

4764 (GEOG 4764) (SOC 4764): INTERNATIONAL DEVELOPMENT POLICY AND PLANNING
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required. (3H,3C)

4854: PLANNING OF THE URBAN INFRASTRUCTURE
Course examines the interdependences among the elements of the built environment of the city and those between the elements of the built environment and the policy/planning structure of the city. Considered are those elements associated with the primary urban activities (residential, commercial, industrial) as well as the urban form-giving infrastructure facilities that support those land uses (water supply, sewerage, solid waste disposal, transportation, education, recreation, health, and safety). Pre: 4754. (3H,3C)

4914: SEMINAR IN PUBLIC AND URBAN AFFAIRS
This capstone seminar explores the central questions of the role of the citizen and the citizenry in democratic capitalistic urban societies as well as the nature of accountability in such regimes. Topics such as the processes by which representation occurs, alternate theories of democratic community and the relationship of the public, private and civil sectors in urban society are treated. Senior status in PUA required. PUA majors and minors must complete this course with a C grade or higher to graduate; otherwise course must be repeated. Pre: 4754, SPIA 2554, SPIA 3554. (3H,3C)

4954: STUDY ABROAD
Variable credit course.

4964: FIELD STUDY
Variable credit course. X-grade allowed.

4964H: HONORS FIELD STUDY
Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course. X-grade allowed.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Statistics

Head: R. Fricker
Professors: S. Keller, R. Gramacy, D. Higdon, I. Hoeschelle, S. Morton, J. Morgan, E. Smith, G. Vining, and W. Woodall
Associate Professors: X. Deng, P. Du, M. Ferreira, F. Guo, Y. Hong, L. House, I. Kim, S. Leman, and G. Terrell
Associate Professor of Practice: F. Faltin and J. Van Mullekom
Assistant Professors: C. Franck, L. Johnson, S. Ranganathan, S. Sengupta, X. Wu, and H. Zhu
Collegiate Assistant Professors: A. Driscoll, C. Lucero, H. Mahmoud, and J. Robertson Evia
Research Assistant Professor: A. Tegge
Instructors: H. Tavera and Z. Zhang

Web: **www.stat.vt.edu**

Overview

Statistics courses are offered at both the undergraduate and the graduate levels for students preparing for professions in statistics, for students who need statistical tools to engage in scientific research, and for students who want to acquire knowledge of the important concepts of probability and statistical inference.

Statistics courses for graduate students and programs leading to the M.S. and Ph.D. degrees in statistics are described in the **Graduate Catalog** and in a special bulletin available from the department.

Bachelor of Science in Statistics

All statistics majors are required to own specified personal computers and software. Consult the department for details.

A special brochure describing the department and the B.S. program, intended for prospective entering freshmen, is available from the department upon request.

Cooperative Education and Internship positions are available in industry and government, offering valuable practical experience. Students participating in such an experience can receive academic credit which will count towards graduation requirements.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Minor in Statistics

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** to view requirements for the minor.

The department reserves the right to withhold credit if a student takes a course, the content of which is partially duplicated in a course already taken (see "Course Duplications" below).

The Statistical Applications and Innovations Group

Associated with the Department, the Statistical Applications and Innovations Group (SAIG) provides assistance for research projects to participating members of the University community and outside organizations. Statistics Department faculty members and students collaborate to design studies, analyze data, and interpret results for Virginia Tech affiliated clients and external clients in business, industry, government, and non-profit organizations. SAIG provides both experiential learning for statistics students and service to the University and beyond. To learn more, visit **https://saig.stat.vt.edu/**.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Statistics can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Course Duplications

- No credit will be given for 2004 if taken with or after any other statistics course, except STAT 2984.
- For non-majors, all of the following are partial duplications: 3005, 3604, 3615, 4604, and 4705.
- For majors, 4604 and 4705 may replace 3005 if taken before becoming a major.
- All the following are partial duplications: 3006, 3616, and 4706.
- No credit will be given for 3704 if taken after any of the following: 3005, 3615, 4604, and 4705.
- BIT 2405 may not be used as a substitute for credit as a statistics course unless the student was officially registered as a Business major at the time BIT 2405 was taken.

Computer Literacy

Many statistics courses involve the use of statistics software, primarily MINITAB, SAS, JMP or R. Experience with the software is not expected, but students should have familiarity with either the Windows or Macintosh operating system and have access to a computer.

Course Projects

Many of the upper-division courses include a project, generally to be completed in small groups. These projects are designed to give students the kind of insight and experience in realistic statistical practice that cannot be obtained in classroom lectures or short-term homework assignments.

Undergraduate Course Descriptions (STAT)

1004: THE FIRST YEAR EXPERIENCE IN LEARNING FROM DATA
Introduction to the field of statistics and aspects of college life for first year students. Topics included: history of the statistics; key roles of statisticians in field, such as actuarial sciences, pharmaceutical, medical, and bioinformatics industries, governmental agencies, academia; fundamental principles of statistical fields of study and applications; exploring data sets; and aspects of college life for first-year students. (2H,2C)

1014: DATA IN OUR LIVES
Develop and practice the process of thinking critically with data in the context of real world problems. Import, manage, summarize, and visualize data using programmable, statistical software. Make data discoveries, make decisions, generate hypotheses, and/or communicate findings in data. Consider laws of probability and personal biases to weigh decisions. Recognize ethical issues and vulnerabilities in analyses when learning from data and extrapolating to large populations. (3H,3C)

1984: SPECIAL STUDY
Variable credit course.

2004: INTRODUCTORY STATISTICS
Fundamental concepts and methods of statistics with emphasis on interpretation of statistical arguments and statistical reasoning. Using modern, accessible statistical software and technology, an introduction to design of experiments (including data collection), data analysis, data visualization, correlation and regression, concepts of probability theory, sampling errors, confidence intervals, and hypothesis tests. Include real-world applications to develop problem-solving skills and consider ethical implications within the context of learning from data. Pre: MATH 1014 or MATH 1025 or MATH 1225 or MATH 1524 or MATH 1525. (3H,3C)

2524: DATA SCIENCE
Organize, summarize, and visualize large-scale datasets from web studies. Interpret visualizations and

communicate information discovered by data explorations. Program in R or comparable statistics programming language. Not intended for statistics majors. Pre: (3005 or 3615), (MATH 1114, MATH 1206 or MATH 2015), (CS 1054 or CS 1064). (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3005-3006: STATISTICAL METHODS
3005: Basic statistical methodology: exploratory data techniques, estimation, inference, comparative analysis by parametric, nonparametric, and robust procedures. Analysis of variance (one-way), multiple comparisons, and categorical data. Includes real-world examples. Develops problem-solving skills and ethical reasoning within the context of learning from data. 3006: Analysis of variance, simple and multiple, linear and nonlinear regression, analysis of covariance. Use of MINITAB. STAT 3005 duplicates STAT 3615 and STAT 4604, only one may be taken for credit. STAT 3006 duplicates STAT 3616, STAT 4604 and STAT 4706, only one may be taken for credit. Co: MATH 1206 or MATH 1226 for 3005. Pre: MATH 1205 or MATH 1225 for 3005; 3005 for 3006. (3H,3C)

3094: SAS PROGRAMMING
Introduction to basic programming techniques: creating DATA and PROC statements, libraries, functions, programming syntax and formats. Other topics include loops, SAS Macros and PROC IML. Emphasis is placed on using these tools for statistical analyses. The pre-requisite may be substituted for an equivalent course. Pre: 3005 or CMDA 2006. (3H,3C)

3104: PROBABILITY AND DISTRIBUTIONS
Probability theory, including set theoretic and combinatorial concepts; in-depth treatment of discrete random variables and distributions, with some introduction to continuous random variables; introduction to estimation and hypothesis testing. Pre: (MATH 1206 or MATH 1226 or MATH 2015 or MATH 1026 or MATH 1526), (STAT 3005 or S TAT 3615 or CMDA 2006). (3H,3C)

3424: INTRODUCTION TO STATISTICAL NEUROSCIENCE AND IMAGE ANALYSIS
Analysis of data arising in studies in neuroscience and from fMRI neuroimaging. Topics include background on neuroscience and the brain, overview of structural and functional MRI data, introduction to MATLAB, overview of linear models, contrasts, and statistical parametric mapping, experimental design, and Bayesian analysis. Pre: 3006 or 3616. (3H,3C)

3504: NONPARAMETRIC STATISTICS
Statistical methodology based on ranks, empirical distributions, and runs. One and two sample tests, ANOVA, correlation, goodness of fit, and rank regression, R-estimates and confidence intervals. Comparisons with classical parametric methods. Emphasis on assumptions and interpretation. Pre: 3006 or 3616 or 4106 or 4604 or 4706 or CMDA 2006. (3H,3C)

3604: STATISTICS FOR SOCIAL SCIENCE
Statistical methods for nominal, ordinal, and interval levels of measurement. Topics include descriptive statistics, elements of probability, discrete and continuous distributions, one and two sample tests, measures of association. Emphasis on comparison of methods and interpretations at different measurement levels. Includes real-world applications to develop problem-solving skills and ethical reasoning within the context of learning from data. Pre: MATH 1014 or MATH 1025 or MATH 1225 or MATH 1524 or MATH 1525. (3H,3C)

3615-3616: BIOLOGICAL STATISTICS
Descriptive and inferential statistics in a biological context with real-world examples. In analytical contexts, develops problem-solving skills and ethical reasoning. 3615: Fundamental principles, one- and two-sample parametric inference, simple linear regression, frequency data. 3616: One- and two-way

ANOVA, multiple regression, correlation, nonparametrics, using a computer package. STAT 3615 partially duplicates STAT 3005 and STAT 4604, only one may be taken for credit. STAT 3616 partially duplicates STAT 3006, 4604 and 4706, only one may be taken for credit. Pre: MATH 1205 or MATH 1525 or MATH 1225 or MATH 1025 or MATH 1524 or ISC 1105 for 36 15; 3615 for 3616. (3H,3C)

3654 (CMDA 3654) (CS 3654): INTRODUCTORY DATA ANALYTICS & VISUALIZATION
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias. Pre: (CS 1114 or CS 1044 or CS 1054 or CS 1064), (MATH 2224 or MATH 2224H or MATH 220 4 or MATH 2204H or MATH 2406H or CMDA 2005), (STAT 3006 or STAT 4705 or STAT 4714 or CMDA 2006). (3H,3C)

3704: STATISTICS FOR ENGINEERING APPLICATIONS
Introduction to statistical methodology with emphasis on engineering experimentation: probability distributions, estimation, hypothesis testing, regression, and analysis of variance. Only one of the courses 3704, 4604, 4705, and 4714 may be taken for credit. Pre: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H. (2H,2C)

4004: METHODS OF STATISTICAL COMPUTING
Computationally intensive computer methods used in statistical analyses. Statistical univariate and multivariate graphics; resampling methods including bootstrap estimation and hypothesis testing and simulations; classification and regression trees; scatterplot smoothing and splines. Pre: (4105, 4214). (4H,3C)

4024: COMMUNICATION IN STATISTICAL COLLABORATIONS
Theory and examples of effective communication in the context of statistical collaborations. Practice developing the communication skills necessary to be effective statisticians using peer feedback and self-reflection. Topics include helping scientists answer their research questions, writing about and presenting statistical concepts to a non-statistical audience, and managing an effective statistical collaboration meeting. Senior standing in the Department of Statistics. Pre: 4214, 4204. (3H,3C)

4094: INTRODUCTION TO PROGRAMMING IN R
Introduction to R programming techniques with an emphasis on statistical analyses. Topics include: data objects, loops, importing/exporting datasets, graphics, functions, t-tests, ANOVA, linear regression, nonparametric tests, and logistic regression. Pre: 3615 or 3005. (1H,1C)

4105-4106: THEORETICAL STATISTICS
4105: Probability theory, counting techniques, conditional probability; random variables, moments; moment generating functions; multivariate distributions; transformations of random variables; order statistics. 4106: Convergence of sequences of random variables; central limit theorem; methods of estimation; hypothesis testing; linear models; analysis of variance. STAT 4105 partially duplicates STAT 4705, STAT 4714, and STAT 4724, only one may be taken for credit. Pre: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005 for 4105; 4105 for 4106. (3H,3C)

4204: EXPERIMENTAL DESIGNS
Fundamental principles of designing and analyzing experiments with application to problems in various subject matter areas. Discussion of completely randomized, randomized complete block, and Latin square designs, analysis of covariance, split--plot designs, factorial and fractional designs, incomplete block designs. Pre: 3006 or 3616 or 4106 or 4706 or 5605 or 5615 or CMDA 2006. (3H,3C)

4214: METHODS OF REGRESSION ANALYSIS
Multiple regression including variable selection procedures; detection and effects of multicollinearity; identification and effects of influential observations; residual analysis; use of transformations. Non-linear regression, the use of indicator variables, and logistic regression. Use of SAS. Pre: 3006 or 3616 or 4106 or 4706 or 5606 or 5616 or CMDA 2006. (3H,3C)

4364: INTRODUCTION TO STATISTICAL GENOMICS
Statistical methods for bioinformatics and genetic studies, with an emphasis on statistical analysis,

assumptions, and problem-solving. Topics include: commonly used statistical methods for gene identification, association mapping and other related problems. Focus on statistical tools for gene expression studies and association studies, multiple comparison procedures, likelihood inference and preparation for advanced study in the areas of bioinformatics and statistical genetics. Pre: (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005), (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006), (STAT 3006 or STAT 3616 or STAT 4706 or CMDA 2006). (3H,3C)

4444: APPLIED BAYESIAN STATISTICS
Introduction to Bayesian methodology with emphasis on applied statistical problems: data displaying, prior distribution elicitation, posterior analysis, models for proportions, means and regression. Pre: (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005), (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006), STAT 3006 or STAT 3616 or STAT 4 706 or CMDA 2006. (3H,3C)

4504: APPLIED MULTIVARIATE ANALYSIS
Non-mathematical study of multivariate analysis. Multivariate analogs of univariate test and estimation procedures. Simultaneous inference procedures. Multivariate analysis of variance, repeated measures, inference for dispersion and association parameters, principal components analysis, discriminate analysis, cluster analysis. Use of SAS. Pre: 3006 or 4706 or CMDA 2006 or STAT 3616. (3H,3C)

4514: CONTINGENCY TABLE ANALYSIS
Statistical techniques for frequency data. Goodness-of-fit. Tests and measures of association for two-way tables. Log-linear models for multidimensional tables. Parameter estimation, model selection, incomplete tables, ordinal categories, logistic regression. Use of SAS and SPSSx. Pre: 3006 or 3616 or 4106 or 4706 or 5606 or 5616. (3H,3C)

4524: SAMPLE SURVEY METHODS
Statistical methods for the design and analysis of survey sampling. Fundamental survey designs. Methods of randomization specific to various survey designs. Estimation of population means, proportions, totals, variances, and mean squared errors. Design of questionnaires and organization of a survey. Pre: 3006 or 3616 or 4106 or 4706 or 5606 or 5616. (3H,3C)

4534: APPLIED STATISTICAL TIME SERIES ANALYSIS
Applied course in time series analysis methods. Topics include regression analysis, detecting and address autocorrelation, modeling seasonal or cyclical trends, creating stationary time series, smoothing techniques, forecasting and forecast errors, and fitting autoregressive integrated moving average models. Pre: 3006 or 4104 or 4706 or 4714 or 3616 or BIT 2406 or CMDA 2006. (3H,3C)

4584 (MATH 4584): ADVANCED CALCULUS FOR STATISTICS
Introduction to those topics in advanced calculus and linear algebra needed by statistics majors. Infinite sequences and series. Orthogonal matrices, projections, quadratic forms. Extrema of functions of several variables. Multiple integrals, including convolution and nonlinear coordinate changes. Pre: (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H), (MATH 1205 or MATH 1225), (MATH 1206 or MATH 1226), (MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005). (3H,3C)

4604: STATISTICAL METHODS FOR ENGINEERS
Introduction to statistical methodology with emphasis on engineering applications: probability distributions, estimation, hypothesis testing, regression, analysis of variance, quality control. Only one of the courses 4604, 4705, and 4714 may be taken for credit. STAT 4604 partially duplicates STAT 3005, STAT 3615, STAT 3006, STAT 3616 and STAT 4706. Only one may be taken for credit. Pre: MATH 1206 or MATH 1226. (3H,3C)

4654 (CMDA 4654) (CS 4654): INTERMEDIATE DATA ANALYTICS AND MACHINE LEARNING
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regularization, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks. Pre: (3654 or CMDA 3654 or CS 3654), (STAT 3104 or STAT 4706 or CMDA 2006). (3H,3C)

4664 (CMDA 4664): COMPUTATIONAL INTENSIVE STOCHASTIC MODLEING
Stochastic modeling methods with an emphasis in computing are taught. Select concepts from the classical and Bayesian paradigms are explored to provide multiple perspectives for how to learn from complex, datasets. There is particular focus on nested, spatial, and time series models. Pre: (4106 or CMDA 3605), (CS 1114 or CS 1064 or STAT 2005). (3H,3C)

4705-4706: PROBABILITY AND STATISTICS FOR ENGINEERS
Basic concepts of probability and statistics with emphasis on engineering applications. 4705: Probability, random variables, sampling distributions, estimation, hypothesis testing, simple linear regression correlation, one-way analysis of variance. 4706: Multiple regression, analysis of variance, factorial and fractional experiments. Only one of the courses 3704, 4604, 4705, 4714, and 4724 may be taken for credit. Pre: MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H for 4705; 4705 or 4105 for 4706. (3H,3C)

4714: PROBABILITY AND STATISTICS FOR ELECTRICAL ENGINEERS
Introduction to the concepts of probability, random variables, estimation, hypothesis testing, regression, and analysis of variance with emphasis on application in electrical engineering. Only one of the courses 3704, 4604, 4705, 4714 and 4724 may be taken for credit. Pre: MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H. (3H,3C)

4804 (AAEC 4804): ELEMENTARY ECONOMETRICS
Economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations. Pre: (3005 or 3604 or CMDA 2006), (AAEC 1006). (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Science, Technology, and Society

Head: Daniel Breslau
Alumni Distinguished Professor: G.L. Downey
Professor: J.E. Abbate and B.L. Allen
Associate Professors: D. Breslau, J. H. Collier, E. Crist Patzig, S.E. Halfon, P.R. Olson, S. Schmid, and M. Wisnioski
Assistant Professors: A.S. Heflin, R. Hester, and L. Vinsel
Collegiate Associate Professor: M. Goodrum
Emeritus Professor: R.M. Burian, E.R. Fuhrman, A.F. LaBerge, and D.T. Zallen
Post-Doctoral Fellow: Fabian Prieto-Nanez
Director of Graduate Studies: S. E. Halfon
Director of Undergraduate Studies: M. Wisnioski
Undergraduate Coordinator: Carol Sue Slusser

Web: **www.sts.vt.edu**

Overview

The Department of Science, Technology, and Society (STS) offers interdisciplinary work at both the

undergraduate and graduate levels that contributes to our understanding of the relations among science, technology, and society. At the undergraduate level, it offers four minors.

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Humanities, Science, and Environment Minor (HSE)

This minor provides an interdisciplinary approach to environmental issues, integrating humanities, social sciences, and natural sciences to understand the relationship between people and the natural world.

Humanities, Science, and Technology Minor (HST)

This minor may be designed to emphasize combinations of moral, aesthetic, intellectual, political, historical, philosophical, and sociological dimensions of science, technology, and medicine, through case studies and in-depth analysis. Students work with the undergraduate coordinator in STS to design a coherent program.

Science and Technology Concentration (ST)

This individualized concentration requires in-depth study and practice of theories and methods of science and technology. Students choose a concentration in one science or technology program; coupled with 9 credit hours of STS courses; the student's program of study must be approved by the STS undergraduate coordinator. In some fields, more than 18 credit hours may be required to complete the concentration.

Medicine and Society Minor (MSOC)

The Medicine and Society minor focuses on the humanistic aspects of medical practice, pressing bioethical questions, and the subjective experience of illness and health. The MSOC minor provides an essential education for anyone curious about the role of medicine in past eras and contemporary culture, and it provides an excellent background for those considering a career in medicine or other health care professions. The minor requires 21 credit hours with at least 14 hours at the 3000 or 4000 level.

Gender, Science, and Technology Minor (GST)

Co-developed by Women's Studies and STS, this minor offers the opportunity for students to cultivate an understanding of the complex ways in which gender is defined in relation to science and technology, and science and technology are defined in relation to gender. The minor coordinator is the Director of the Women's Studies Program.

Contact Carol Sue Slusser in 121 Lane Hall or vie email at slusserc@vt.edu, for more information or to enroll in one of these minors.

Graduate Program in Science and Technology Studies

STS jointly administers the Science and Technology Studies Graduate Program with contributing and affiliated faculty from the departments of History, Philosophy, Political Science, and Sociology. The program offers the M.S. and Ph.D. degrees at both the Blacksburg and National Capital Region campuses. (See the **Graduate Catalog** for further information.)

Undergraduate Course Descriptions (STS)

1504: INTRODUCTION TO SCIENCE, TECHNOLOGY, AND SOCIETY
Examination of the interrelationship among science, technology, and society. Study of how science, technology, and medicine are defined and analyzed by the humanities and social sciences. Examination of topics, theories, and methods of the field of Science and Technology Studies. Depiction of the dynamics of scientific and technological controversies including the roles knowledge, expertise, risk, rhetoric and public understanding play in policy making. (3H,3C)

2054 (HIST 2054): ENGINEERING CULTURES
Development of engineering and its cultural values in historical and transnational perspectives. Explores the varying knowledge, identities, and commitments of engineers and engineering across different countries. Examines values in emergent infrastructures of engineering education and work, and the participation of engineers and engineering in evolving forms of capitalism. Helps students learn to reflect critically on their knowledge, identities, and commitments in varying curricula and a globalizing world. (3H,3C)

2154: THE LIFE SCIENCES AND SOCIETY
Basic Science, Technology, and Society (STS) perspectives on the life sciences and the ethical issues they raise. Humanistic approaches to analyze how our values and perceptions are informed by the ways that we understand bodies, biology, and life itself. How our hopes, desires, and fears shape the practices and technologies of the life sciences. (3H,3C)

2254: INNOVATION IN CONTEXT
Critical examination of diverse definitions and examples of innovation. Discussion of innovation as a process of social change; as technology diffusion; as an economic engine; as an ecosystem; as an ideology; and more. Introduction to methods and ideas from the field of Science and Technology Studies including the analysis of innovation from historical, cultural, and economic perspectives, as well as the study of innovation's consequences and its alternatives. Collaborative projects focused on creatively describing and critiquing local cases of innovative work. (3H,3C)

2354: HUMANITIES, TECHNOLOGY, AND THE PHYSICAL SCIENCES
Examines the value-laden issues surrounding the professional dimensions of research in the physical sciences and technology, and provides humanistic perspectives on the role and function of science in society. (3H,3C)

2444: GLOBAL SCIENCE AND TECHNOLOGY POLICY
Introduction to issues and themes in global science and technology policy, from the perspective of Science and Technology Studies (STS). Comparison of national and international policy agents, institutions, structures, and processes. Integration of key ideas from STS into policy analysis, including regulatory cultures, cultural notions of risk and expertise, large socio-technical systems, and social shaping of technology. Emphasis on international controversies, diverse cultural perspectives, and inclusion in policy processes. Cases may include international controversies over genetically modified foods, transmissible illnesses, nuclear energy, and information security. (3H,3C)

2454: SCIENCE, TECHOLOGY, AND ENVIRONMENT
Examines the nature and causes of global environmental challenges. Focuses on the role of science and technology in the causation of environmental problems and provision of solutions. Investigates uneven impacts among different groups and nations. Explores multicultural dimensions and ethical debates in the relationship between humanity and natural world. Considers visions of alternative futures. (3H,3C)

2464 (RLCL 2464): RELIGION AND SCIENCE
Exploration of the relationships between religion and science in the western tradition. Basic frameworks for relationships between religion and science in historical and cultural context, types of human knowledge and truth, similarities and differences between science and religion, evolution, the origins of the creationist movement, and contemporary moral and ethical issues. (3H,3C)

2604 (HIST 2604) (SOC 2604): INTRODUCTION TO DATA IN SOCIAL CONTEXT
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures. (3H,3C)

2715,2716 (HIST 2715, 2716): HISTORY OF TECHNOLOGY
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens' groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3105,3106: SCIENCE AND TECHNOLOGY IN MODERN SOCIETY
Examination of science and technology as social and cultural activities in the modern world. 3105: institutions and values in science and technology; 3106: value conflicts and decision making in science and technology. (3H,3C)

3284: TECHNOLOGY AND DISABILITY
Technologies and the experience of disability. The ways institutions, laws, and biases influence how disability is interpreted within engineering and design culture. How disability communities resist, negotiate, adopt, make, and change technologies. Development of work on this topic through making, doing, and writing. Conversations about ableism, media portrayals, historical narratives, ideology, and rhetoric surrounding technology and disability. Includes field trips to learn about the law and assistive technology. (3H,3C)

3314: MEDICAL DILEMMAS AND HUMAN EXPERIENCE
Provides a humanist perspective on dilemmas of medical ethics. Focus on the varieties of human experience of medical dilemmas. Topics include contemporary controversies, such as assisted reproduction, genetic testing and treatment, clinical trials, end-of-life interventions, and the allocation of health-care resources. (3H,3C)

3334: ENERGY AND SOCIETY
Examines the interconnections between energy use and social life. Considers the ways that modern social institutions, such as states, cities, and households are shaped by energy systems, particularly the pervasive use of fossil fuels. Explores the influence of energy extraction and commerce on economic development and global politics. Surveys major contemporary problems related to energy, including climate change and natural resource depletion. Develops an interdisciplinary framework, drawing insights from history, sociology, and economics, for evaluating policies to transition to a sustainable energy system. (3H,3C)

3504: THE PRACTICE OF COLLABORATIVE RESEARCH IN STS

Reinforces concepts and perspectives in Science, Technology, and Society through collaborative research projects. Provides experience with major research techniques used in STS, such as interviewing, ethnography, and documentary research. Covers a range of presentation formats for academic communication and public outreach. Research topics involving contemporary problems related to science and technology. Pre: 1504, (2154 or 2444 or 2454 or 2254). (3H,3C)

3705,3706 (HIST 3705, 3706): HISTORY OF SCIENCE
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science (3H,3C)

3734 (HIST 3734): HISTORY OF MODERN BIOLOGY
This course explores the development of biology from the Enlightenment to the end of the twentieth century, with a particular emphasis on biology's impact on society. (3H,3C)

3984: SPECIAL STUDY
Variable credit course.

4304: CONTEMPORARY ISSUES IN SCIENCE, TECHNOLOGY, AND SOCIETY
Examination of social and cultural issues that shape, and are shaped by, the conduct of scientific, technological, and medical research and activity. Topics such as human genetic and technological enhancement; surveillance technologies and civil rights; environmental intervention and preservation; precautionary and proactionary approaches to public policy making. Course repeatable up to 12 hours with different topics. Junior Standing. (3H,3C)

4314 (ENGL 4314): NARRATIVE MEDICINE
Introduction to the field of narrative medicine, with attention to narrative competencies, the use of narrative medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics. Pre: ENGL 1106 or ENGL 1204H or COMM 1016. (3H,3C)

4314H (ENGL 4314H): NARRATIVE MEDICINE
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics. Pre: ENGL 3154 or ENGL 3324. (3H,3C)

4334 (WGS 4334): SEXUAL MEDICINE
Discusses sex and medicine in contemporary U.S. society. Explores how notions of sexual behavior and "normality" are defined and structured by medical discourse. Examines cultural institutions that play significant roles in formulating ideas about and definitions of deviance, perversity, and tolerated marginality. Critiques medical responses to sexual variations. Examines experiences of people who have sought out, or been the unwilling victims of, sexual medicine. Junior standing required. Pre: WGS 1824. (3H,3C)

4704 (WGS 4704): GENDER AND SCIENCE
Investigates the gender dimensions of science in both historical and contemporary perspectives. Discusses feminist studies of science, exploring strengths and limitations. Assess implications of cultural assumptions about gender for practicing scientists. A 3000 level course in science or engineering may satisfy the prerequisite. Pre: 1504 or WGS 2244. (3H,3C)

4754: INTERNSHIP
Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Systems Biology

Division Leader: I. Lazar
Program Manager: C. Conley
Principle Faculty: F. Alyward, W. Baumann, D. Bevan, Y. Cao, J. Chen, S. Ciupe, R. Jensen, S. Kojima, P. Kraikivaki, I. Lazar, L. Li, T.M. Murali, and J. Tyson

Web: **www.ais.science.vt.edu/programs.sysbio.html**

Overview

The Systems Biology program is a joint effort of the departments of Biological Sciences, Physics, Chemistry, Mathematics and Computer Science. The program resides in, and is organized as a division of, the College of Science's Academy of Integrated Science.

A "systems approach" to biology involves the study of the biological, chemical, and physical processes within living organisms as they interact in complex ways to produce life-supporting behaviors. The Virginia Tech program in Systems Biology focuses on the powerful, emerging paradigm of molecular systems biology, i.e., on computational, systems-level approaches that connect the biochemical and genetic properties of individual macromolecules (DNA, RNA, protein, lipids, polysaccharides) with the physiological behavior of living cells and tissues. These levels of biological organization, which comprise the gap between interacting macromolecules and cell physiology, embody an active area of research producing technological and biomedical innovations. The Systems Biology program bridges the molecular/cell divide, training students for employment or graduate education in this burgeoning field.

Bachelor of Science in Systems Biology

Degree Requirements

The graduation requirements in effect at the time of graduation apply. When choosing the degree requirements information, always choose the year of your expected date of graduation. Requirements for graduation are referred to via university publications as "Checksheets". The number of credit hours required for degree completion varies among curricula. Students must satisfactorily complete all requirements and university obligations for degree completion.

The university reserves the right to modify requirements in a degree program. However, the university will not alter degree requirements less than two years from the expected graduation year unless there is a transition plan for students already in the degree program.

Please visit the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html** for degree requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways to General Education) (see "**Academic Policies**") and toward the degree.

Satisfactory progress requirements toward the B.S. in Systems Biology can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Minor in Systems Biology

Please visit the University Registrar's website at **https://www.registrar.vt.edu/graduation-multi-brief/checksheets/minors/index.html** for requirements toward a minor in Systems Biology.

Undergraduate Course Descriptions (SYSB)

2025,2026: INTRODUCTION TO SYSTEMS BIOLOGY
Introduction to the fundamental ideas and methods of systems biology by a series of case studies. Applications of statistical methods and computer simulation. 2025: Genome analysis, molecular network architecture, dynamical systems. 2026: Molecular regulatory systems, metabolic pathways, data mining. Pre: ISC 1106 or (BIOL 1105, CHEM 1036, MATH 1026) or (BIOL 1105, CHEM 1036, MATH 1226). (3H,3C)

2984: SPECIAL STUDY
Variable credit course.

2994: UNDERGRADUATE RESEARCH
Variable credit course.

3035-3036: SYSTEMS BIOLOGY OF GENES AND PROTEINS
Experimental techniques in genomics, transcriptomics, and proteomics. Mathematical, statistical, and computational models and methods to analyze these data. Techniques for integrating data from different experiments. Case studies and specific applications in molecular biology, including cancer and infectious diseases. 3035: genomics, transriptomics. 3036: proteomics, interactomics, data integration. Pre: 2026 or 2025 for 3035; 2026 for 3036. (3H,3L,4C)

3115-3116: NETWORK DYNAMICS AND CELL PHYSIOLOGY

In-depth study of how molecular regulatory networks determine the physiological properties of prokaryotic and eukaryotic cells. 3115: Biochemical reaction networks, nonlinear dynamical systems, parameter estimation, bifurcation theory, switches and oscillators, gene regulatory networks, signaling pathways, metabolic networks, neural networks, applications. 3116: Stochastic effects, cell cycle and cancer, spatial effects, motility, development, tissue dynamics, applications. Pre: 2025 or 2026 for 3115; 3115 for 3116. (3H,3L,4C)

4065-4066: RESEARCH EXPERIENCE IN SYSTEMS BIOLOGY
Training and practical experience in the conduct of systems biology research. 4065: Planning a research project and initial execution. 4066: Refine, complete, and document projects results. Pre: 3036, 3116 for 4065; 4065 for 4066. Co: 4135 for 4065; 4136 for 4066. (4H,4C)

4135-4136: PROFESSIONALISM IN SYSTEMS BIOLOGY
Training and practical experience in ethical standards of science. 4135: Systems biology, proposal writing, ethical issues, the impact of systems biology on national and global issues, career options. 4136: Oral and written presentations, management and social issues, current literature and developments in systems biology. Pre: 3036, 3116 for 4135; 4135 for 4136. Co: 4065 for 4135; 4066 for 4136. (2H,2C)

4994: UNDERGRADUATE RESEARCH
Variable credit course.

Menu

2019-2020 Undergraduate Course Catalog and Academic Policies

Theatre and Cinema

Director, School of Performing Arts | Music | Theatre | Cinema: TBD, Interim
Faculty Chair: Natasha Staley
Professors: R. H. Leonard, S. Prince, P. Raun, and R. W. Ward
Associate Professors: J. Ambrosone, D. W. Johnson, G. W. Justice, A. Nelson, C. Rawlings, S. C. Rinehart, and N. Staley
Assistant Professors: C. Dye, G.S. Hardwig, J. Perkinson, J. Stein, and T. Vintu
Instructors: K. Precoda and W. Heatherington Tilka
A.P. Faculty: K. Murphy and K. Skelly
Associate Professor of Practice: C. Russo
Career Advisors: All faculty
Emeritus Professors: D. A. Drapeau, B. Dukore, D.W. Johnson, P. Lavender, F. N. Proctor, and R.W. Wardr

Web: **www.performingarts.vt.edu**

Overview

The curriculum in Theatre and Cinema is designed to provide the student with the essential approaches necessary to develop an informed understanding of Theatre and Cinema literature and its practice. As such, the three basic aspects of the disciplines (the theoretical, the historical, and the practical) are emphasized.

A program in theatre arts leading to the B.A. is offered. In addition to fulfilling the core curriculum requirements of the College of Liberal Arts and Human Sciences and the Curriculum for Liberal Education, general majors who choose the general degree option must complete a minimum of 48 hours in theatre arts. Students who choose a degree option in Performance, Design, or a Cinema major, must complete a minimum of 57 hours.

A minor course of study in theatre or cinema may be chosen with the guidance of the student's advisor.

Limited scholarship support is available.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "**Academics**") and toward the degree in Theatre Arts.

Satisfactory progress requirements toward the B.A. in Theatre Arts can be found on the major checksheet by visiting the University Registrar website at **http://registrar.vt.edu/graduation-multi-brief/index1.html**.

Undergraduate Course Descriptions (CINE)

2054: INTRODUCTION TO CINEMA
Introduction to cinema as a medium for artistic communication. Interpretation and analysis of films to understand designs, ideas and values in artistic and cultural contexts. Basic elements of cinema structure and cinema terminology, phases of cinema production, cinema style of individual directors, creative work of cinematography, production design, and editing, ideological and social meaning in cinema, demographics of visual representation, cinema's economic marketplace. Ethical values and conflicts as found in given films, and ethical reasoning as part of the analysis of cinema. (2H,3L,3C)

2064: INTRODUCTION TO CINEMA PRODUCTION
Introductory filmmaking course. Thematic conception and story construction, writing, producing, directing, cinematography, sound recording, and editing. (3H,3C)

3184: CINEMA PRODUCTION TOPICS
Rotating topics in cinema production. Designed for majors in the Department of Theatre and Cinema who have foundational training in areas of cinema production. May be repeated for credit with different course content up to a maximum of nine credit hours. Variable credit course. Pre: 3214 or 3224.

3214: FICTION CINEMA PRODUCTION
Intermediate-level fiction film production course. Foundational cinema production skills, dramatic storytelling techniques, intermediate directing, team- based ownership and responsibility, and project management. Pre: 2054, 2064. (3H,3C)

3224: DOCUMENTARY CINEMA PRODUCTION
Intermediate-level, non-fiction, film production course for students seeking non-fiction documentary film production skills and experience. Emphasizes the application and advancement of foundational skills, the ethics of documentary filmmaking, story development and project management. Pre: 2054, 2064. (3H,3C)

3444 (AFST 3444): AFRICAN AMERICAN IMAGES IN FILM
Explores race and representations of African American images in film, from multiple disciplinary perspectives. Focuses on the social, political, economic, and historical milieu in which black film emerged and evolved. Examines gender issues in filmmaking. Reviews different genres, including race films, colorblind representations, and black exploitation films, and the appropriation of black representation and black images in film in the United States and elsewhere. Includes methods of film analysis, such as historical, master narrative structure, and archival research. Pre: AFST 1714. (3H,3C)

3514: AMERICAN CINEMA GENRES
Close visual and cultural study of classic film genres with emphasis on cinematic styles and narrative conventions which unify the genre and which are found in representative films; exploration of genre films as symbols of American culture and society. Specific thematic content is variable. Course may be repeated with different course content for up to 9 credits. Pre: TA 2054 or CINE 2054. (3H,3C)

3524: THE CINEMA DIRECTOR
Close thematic and visual analysis of the films of prominent cinema directors; emphasis on cinematic structure and development and evolution of their work. Specific thematic content is variable. Course may be repeated with different course content for up to 9 credits. Pre: TA 2054 or CINE 2054. (3H,3C)

3534: AVANT-GARDE CINEMA
Close visual and cultural study of the avant-garde and experimental tradition in the first half-century of American and European cinemas; emphasis on interrelations of cinema with avant-garde movements in other arts, including literature, music, dance, theatre, painting, and photography Pre: 2054. (3H,3C)

3544 (ENGL 3544): LITERATURE AND CINEMA
Works of literature and the films into which they have been transformed; emphasis on differences between media. (3H,3C)

4084: CINEMA HISTORY
Aesthetic, economic, social and technological history of world cinema; film theory as it relates to the history of cinema. Junior standing required. Variable credit course. Pre: 2054.

4144: TOPICS IN CINEMA STUDIES
Critical issues in cinema. Aesthetic, social, political, and economic contexts for films that embody or critique assumptions of historical periods. Analysis of ethnocentric and cultural biases in cinema. Identifying issues of identity and equity in films. Theories and ethics of representation. May be repeated 2 times with different content for a maximum of 9 credits. Pre: 2054. (3H,3C)

4534: UNDERGROUND CINEMA AND CULTURE
Close visual and cultural study of underground cinema and culture from the 1940s through the 1970s; emphasizes the interrelations of cinema with countercultural movements in other arts, including literature, music, dance, theatre, painting, and photography; focuses on the post-war avant-garde, the emergence of film societies, the neorealist and new wave cinemas, challenges to censorship laws, and the emergence of cult and "midnight movies." Pre: 2054. (3H,3C)

Undergraduate Course Descriptions (DANC)

2004: ANATOMY FOR PERFORMERS
An experiential course merging the artistic, experiential, and conceptual understanding of the human body, and how all of its elements work together to produce motion and the sense of being. Study of the anatomical structures of the body through an experiential lens of motion and sensory perception. Introduction of the concepts of kinesiology through the study of bone, joint, tissue, muscular, and organ structures. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to practices of equitable embodied identity. Lecture, demonstration, and experience-based partnering work that draw from a variety of somatic traditions including yoga, pilates, Body-Mind Centering, release technique, Alexander and Feldenkrais techniques, Gyrotonic/Gyrokinesis, and mediation. Designed for performers in the arts, athletes, martial artists, or any students wishing to study the body from an experiential lens. (3H,3C)

2014: INTRODUCTION TO DANCE HISTORY
Survey of dance history as an art form with global scope. Language of dance criticism and dance writing practices. International dance forms and the emergence and development of 20th and 21st century modern and post-modern concert dance in the United States from the confluence of European folk and court dances, ballet, African and Caribbean influences, and other American cultural dynamics. Emphasis on ethical and aesthetic modes of viewing dance performance with attention to issues of gender and sexuality, race and ethnicity, ability, class, and identity. (3H,3C)

2024: INTRODUCTION TO DANCE TECHNIQUES
Beginner-level studio dance course. Introduction of movement techniques, improvisation/composition, performance, experiential anatomy, and an overview to concepts in dance history. Development of flexibility, strength, coordination, rhythm, and vocabulary in the modern idiom. Concepts of time, space, energy, and choreographic form presented through set movement exercises, improvisation, and a final compositional project. Training in a variety of movement vocabularies including modern/contemporary, ballet, and cultural dance forms. May be repeated once with different content for a maximum of 6 credits. Design Lab/Studio. (5L,3C)

3024: INTERMEDIATE/ADVANCED DANCE TECHNIQUES
Intermediate/advanced level course in movement techniques. Training in a variety of movement vocabularies including modern/contemporary, ballet, and cultural dance forms. Improvisation/composition, performance, concepts in anatomy/kinesiology, and 21st century contemporary dance forms. Development of flexibility, strength, coordination, rhythm, vocabulary in the modern idiom, and focused study of partnering concepts from a variety of hybrid forms. Concepts of time, space, energy, and choreographic form presented through set movement exercises and two compositional projects. May be repeated 3 times with different content for a maximum of 9 credits. Design/Lab Studio. Pre: 2024. (5L,3C)

Undergraduate Course Descriptions (FA)

2004: CREATIVITY AND THE ARTISTIC EXPERIENCE
Examine how the arts intersect with our daily lives. Compose and create basic examples of abstraction and 20th century modernism. Trace the global influences and roots of our current culture. Explore the science of acoustics and its effect on performing spaces. Discuss the process of an arts performance. Apply themes of improvisation, creativity and how we process beauty. Investigate emerging brain science as it relates to art, beauty and pleasure. Identify the unique ways of knowing embodied in the arts distinct from scientific measurements. No prior knowledge of visual, theatrical or musical arts needed. (3H,3C)

Undergraduate Course Descriptions (TA)

1004 (MUS 1004): SCHOOL OF PERFORMING ARTS FIRST YEAR EXPERIENCE
Orientation to the School of Performing Arts philosophy and the resources of the School, the College, and the University. Cultivate a common intellectual, analytical, and creative conversation among first-year students. Enhance student participation in the creative and scholarly life of the School’s programs. Foster a sense of community and understanding across disciplines. (1H,1C)

2014: INTRODUCTION TO THEATRE
Appreciation and understanding of theatre as a living, collaborative art form through historical and intercultural perspectives, readings of key texts and analysis of scripts, and explorations of all elements of the theater making process, including playwriting, directing, acting, and design. (3H,3C)

2024: INTRODUCTION TO ACTING
Introductory performance class in acting skills and theories as a participant (actor) and observer (audience) for the non-major. Includes performances of dramatic literature/ improvisation for live audience, creating character biography and script analysis, historical and intercultural contexts, and techniques in constructive criticism that incorporate interpretive strategies. (3H,3C)

2104: FUNDAMENTALS OF THEATRE AND PRODUCTION
Introduction to theatre vocabulary and understanding of the theatrical process, theatre aesthetics, theatrical modes of expression, basic script analysis, production analysis, theory and practice of collaboration, theatre organizations, history and operations of professional theatres. (T & C majors and minors only). (3H,3C)

2114: SCRIPT ANALYSIS
Understanding of drama as an element of theatre with focus on the process of script analysis for theatrical production. (3H,3C)

2134: ACTING LAB
An introduction to the process of acting, through a variety of laboratory experiences, beginning with basic performance skills and culminating in the performance experience. Emphasis is on improvisation, terminology, physical action, script analysis, characterization, and rehearsal and performance techniques. Limited to Theatre & Cinema Majors. (6L,3C)

2135,2136: THEATRE DESIGN LAB
An introduction to the processes, technologies, and aesthetics of the visual design of theatrical productions. 2135: Scenography, costume, and stage lighting design are explored in history and contemporary theatre practice. 2136: A range of design problems will offer opportunity to learn various design approaches and provide practice with different media and means of design expression. (6L,3C)

2144: FOUNDATIONS OF MOVEMENT AND VOICE
An introduction to the process of acting, through a variety of laboratory experiences, beginning with basic performance skills and culminating in the performance experience. Emphasis is on various methods of performance style and analysis, theater movement and body conditioning, and vocal awareness and production. Limited to Theatre & Cinema Majors. Pre: 2134. (6L,3C)

2204: CREATIVE DANCE
Study of the expressive elements of movement and dance. Basic choreographic procedures and small group work to design dances that emphasize particular movement concepts. Experience in music and movement of diverse dance cultures. Documentation of the pathways of dances in floorplans and written reflections on the creative processes. (3H,3C)

2224: INTERMEDIATE PERFORMANCE INTENSIVE
This course provides the Theatre & Cinema major, who desires a rigorous exploration of acting, a forum for application of the techniques and skills learned. These skills will be strengthened and applied through observation of and participation in scene and monologue work. Focus will be placed on basic skills and concepts necessary to creative, truthful, and believable performance of selected scenes, including use of voice and body, imagination, relaxation, sense and emotion memory, and script analysis. Limited to Theatre & Cinema Majors. Pre: 2134, 2144. (3H,3C)

2404: INTRODUCTION TO APPLIED COLLABORATIVE TECHNIQUES
Introduction to principles of collaboration in applied theatre for non-majors. Situational awareness, intrapersonal and interpersonal awareness, audience engagement, effective storytelling, team creativity and conflict resolution, and communicating across difference in public and professional settings. (3H,3C)

2414: STAGE AND LIGHTING TECHNOLOGY
A practical study of the technologies and specialized equipment employed in the construction, rigging and running of theatrical production; the planning and organization involved in mounting these productions; the tools, materials and techniques used to realize theatrical design and build scenery; and the fundamentals of stage lighting. (3H,3C)

2604 (MUS 2604): INTRODUCTION TO ARTS MARKETING
An introduction to the theories and practice of marketing and building community engagement as applied to arts activities and professional not-for-profit arts organizations, through a survey of standard marketing approaches, examination of current practices in the field, and direct hands-on experience. (3H,3C)

2964: FIELD STUDY
Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY

Variable credit course.

2984G: SPECIAL STUDY
Variable credit course.

2984M: SPECIAL STUDY
Variable credit course.

3014: THEATRE PRODUCTION LAB
Production experiences in the areas of performance, design and theatre technology, management, and writing. May be repeated for a maximum of nine credits. Variable credit course. X-grade allowed.

3024: INTERMEDIATE ACTING FOR NON-THEATRE MAJOR
Performance class in acting skills, theories, and genres. Designed for non-theatre arts majors. Builds on fundamentals and theory learned in Introduction to Acting. Includes body and voice awareness, performance of specific genres, and expanded acting theory and analysis. Pre: 2024. (3H,3C)

3105,3106: HISTORY OF DRAMA AND THEATRE
History of drama and theatre from primitive ritual to the present day and its relationship to the social, economic, and political forces from age to age. 3105: primitive, Greek, Roman, Medieval, Renaissance, and Asian. 3106: Restoration, eighteenth, nineteenth, and twentieth centuries. Junior standing required. Pre: 2114. (3H,3C)

3114: SCENOGRAPHY TOPICS
Rotating topics in scenography and related specific design applications. Designed for theatre arts majors who have foundational training in areas of theatre design. May be repeated for credit. Variable credit course. Pre: 2135, 2136.

3124: COSTUME DESIGN AND TECHNOLOGY TOPICS
Rotating topics of costume design and costume technology. Designed for advanced theatre arts majors who have foundational training in all areas if theatre design. May be repeated for credit. Variable credit course. Pre: 2135, 2136.

3134: LIGHTING TOPICS
Rotating topics in lighting design and technology. Designed for advanced theatre arts majors who have foundational training in all areas of theatre arts. May be repeated for credit. (Variable credit) Variable credit course. Pre: 2135, 2136, 2414.

3144: THEATRE TECHNOLOGY TOPICS
Rotating topics in design and theatre technology. Designed for advanced theatre arts majors who have foundational training in all areas if theatre technology and design. May be repeated for unlimited number of credit hours. Variable credit course. Pre: 2135, 2136, 2414.

3154: ACTING TOPICS
Rotating topics in performance skills and theories. Designed For advanced theatre arts majors who have foundational training in acting, voice and movement. May be repeated for credit. Variable credit course. Pre: 2224, 2144.

3164: VOICE AND SPEECH TOPICS
Rotating topics in voice and speech skills, and theories and practice in performance. Designed for advanced theatre arts majors who have foundational training in acting, voice and movement. May be repeated for credit. Variable credit course. Pre: 2224, 2144.

3174: MOVEMENT TOPICS
Rotating topics in theatre movement, dance for the theatre and theories of physical expression in the performing arts. Designed for advanced theatre arts majors who have foundational training in acting voice and movement. May be repeated for a maximum of 9 credit hours. Variable credit course. Pre: 2144, 2224.

3315-3316 (ENGL 3315-3316): PLAYWRITING
A workshop course in the craft and art of playwriting which emphasizes the development of craft and the nurturing of vision and art. 3315: primary focus is on the writing of original scripts with additional attention paid to the work of influential playwrights and critics. 3316: primary focus is on the creative process of developing a play with the collaborative influences of a director, actors, designers, and other theatre professionals. Consent of instructor required. Pre: ENGL 1106 or ENGL 1204H or COMM 1016 for 3315; 3315 for 3316. (3H,3C)

3604: ARTS MANAGEMENT
The development of the not-for-profit arts organization, structures and characteristics of boards of directors, artistic missions and goals, funding, volunteer support, and fiscal control. Junior standing required. (3H,3C)

3624: STAGE MANAGEMENT
The systems, procedures, forms, and duties of the stage manager in the professional, academic, and community theatre are explored in relationship to the production process and other theatre artists. Pre: 2104. (3H,3C)

3954: STUDY ABROAD
Variable credit course.

3984M: SPECIAL STUDY
Variable credit course.

4014: CONTEMPORARY THEATRE SEMINAR
Issues and concerns in contemporary theatre; production philosophies and approaches, employment opportunities, career options, and preparation of portfolio and resume materials. Junior standing required. (3H,3C)

4304: THEATRE OUTREACH
Participation in theatre projects or activities that focus on community and social issues. May be repeated for a maximum of six credits. Junior standing. Variable credit course.

4315-4316: DIRECTING
Script analysis, theories, techniques, and practical applications of theatrical direction. 4315: Theories and aesthetics of directing, functions of the director, script analysis, basic principles and techniques of staging. 4316: Rehearsal techniques, style determination realism, and non-realism. Senior standing required. (3H,3C)

4704: PROFESSIONAL THEATRE INTERNSHIP
Internship of one semester in acting, directing, management, design, or technical theatre or cinema with a professional equity company for selected advanced students; classroom, workshop, and production experiences. Minimum 9 credits, maximum 15 credits. Audition and consent. Variable credit course.

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY
Variable credit course.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Variable credit course.