

GRADUATE CATALOG 2013-2014

Policies, Procedures, Academic Programs



GRADUATE SCHOOL POLICIES & PROCEDURES

Graduate School Policies and Procedures

Introduction

This document sets forth policies, procedures and requirements relating to graduate study at Virginia Polytechnic Institute and State University (Virginia Tech). The policies in this document have been developed by the Commission on Graduate Studies and Policies (CGS&P) and approved by the faculty governance system of Virginia Tech. This document is designed to assist all those involved in graduate education at the university. The major responsibility for knowing and completing the degree requirements rests with the graduate student. The Advisor (i.e., the Chair of the student's Advisory Committee or Major Professor) and the student's Advisory Committee help the student prepare a Plan of Study (that lists the course work required for the degree) and select an appropriate research topic. The Graduate School seeks to foster quality in all phases of graduate education.

Graduate Student Responsibilities

It is the student's responsibility to satisfy all university requirements described in the Graduate School Policies and Procedures section in the Graduate Catalog, http://graduateschool.vt.edu/graduate_catalog/, as well as any additional requirements established by the faculty in the academic program in which the student is enrolled. Policy changes that occur between revisions of the catalog are described in the Graduate School Blog <https://secure.graduateschool.vt.edu/weblog/monthlymemo/>. In addition to the procedures included in this document, procedural information is available at <http://graduateschool.vt.edu/academics/pg>

Graduate Student Ombudsperson

The Graduate Student Ombudsperson, with an office in the Graduate Life Center, provides confidential help to graduate students to resolve issues and address concerns that arise within the university setting. The ombudsperson provides a resource for and information about institutional policies and acts as a facilitator to work toward resolutions of graduate students' concerns. The office is an informal avenue for graduate students, and consultations are kept confidential, unless the student grants permission for the ombudsperson to discuss issues with involved parties or administrators.

Graduate Honor System

Compliance with the Graduate Honor Code requires that all graduate students exercise honesty and ethical behavior in all their academic pursuits at Virginia Tech, whether the undertakings pertain to study, course work, research, engagement, or teaching. The Constitution of the Graduate Honor System is contained <http://ghs.graduateschool.vt.edu>

Graduate Program Responsibilities

Each graduate program/department that offers graduate degrees or certificates lists the requirements of those degrees or certificates in the Graduate Catalog and in their departmental Graduate Policies document which is available on the departmental website. The Graduate School website provides links to these Degrees and Programs: http://graduateschool.vt.edu/graduate_catalog/programs.htm Each graduate program should identify the graduate program faculty who have ultimate responsibility for the quality of the graduate program in the academic unit. A member of the graduate program faculty serves as the Graduate Program Director for overseeing academic matters in the graduate program and chairs the departmental Graduate Program

Committee. The Department Head//Chair/Director may appoint the Graduate Program Director as the signing authority for all departmental graduate transactions. In some departments, the Department Head serves as the Graduate Program Director. Most programs also have a staff member designated as the Graduate Coordinator who is involved with overseeing many technical aspects of the graduate program. Each department is responsible for developing procedures for Advisory Committees to use in the Annual Evaluation of Progress of each graduate student in the program. These evaluations should consider GPA, courses with grades of Incomplete or other grade problems, progress on the Plan of Study, preliminary exam performance (doctoral students), research performance, teaching performance, assistantship status and performance, general departmental citizenship, and recommendations for the next review period. For those students who have not yet established an Advisory Committee, the evaluation should be conducted by a departmental committee, the Graduate Program Director, or the Department Head. The results of the evaluation, including a Rating indicating whether the student's progress is Satisfactory or Unsatisfactory, should be placed permanently in the student's file in the department and the student should be informed of the results of the annual evaluation. In cases of Unsatisfactory ratings, it is especially important that written, constructive feedback about what the student needs to do to obtain a Satisfactory rating, be included in the evaluation. A summary of these annual evaluations for all students in the program, as well as the copies of the individual student evaluations, should be sent to the Graduate School by the end of Summer II each year (submission of electronic files is encouraged). This review process is mandated by Presidential Policy Memorandum #229 <http://www.policies.vt.edu/policymemos/ppm229.pdf> (2003) which is an update to #1 (1977). Periodic reviews of Graduate Programs and their standards and policies also are required. All programs in the university will be reviewed over a seven year cycle currently in progress. See Presidential Policy Memoranda #14 (1979) <http://www.policies.vt.edu/policymemos/ppm14.html>, #126 (1992) <http://www.policies.vt.edu/policymemos/ppm126.html>, and #152 (1995) <http://www.policies.vt.edu/policymemos/ppm152.html>.

Changes

The university reserves the right to make changes in fees, policies, degree requirements, schedules, or courses offered.

Exceptions to Policy

Exceptions to policies may be requested of the Dean's Office of the Graduate School. A request for an exception should cite the policy, justify the request, and demonstrate appropriate departmental support for the request. Requests for exceptions should come from the graduate student's Advisor and have the support of the Graduate Program Director or Department Head.

Student Life and Related University Policies

University Policies for Student Life

All students enrolled at Virginia Tech are subject to student life policies set by the university. The university publication, University Policies for Student Life is available at <http://www.hokiehandbook.vt.edu/studentlife/>. This document is applicable to students matriculated at the Blacksburg campus, as well as those students at branch campuses, higher education centers, or other university owned or leased properties. In addition, information about medical and health related policies and parking are included below.

Physical Examination

All Blacksburg campus students, admitted to the university for the first time, must complete a physical examination form and return it to Student Health Services <http://www.healthcenter.vt.edu/>

Medical Insurance Coverage

The university has contracted with an insurance carrier to offer group coverage for all students at Virginia Tech. For details on levels of coverage and specific limitation, please contact the Student Medical Insurance office in the Student Services Building, 540/231-6226 or 231-6303, or visit <http://www.co.vt.edu/Risk/studenthealthinsr/index.html>. Medical insurance is mandatory for all international students with F-1 or J-1 visa status and their accompanying dependents in F-2/J-2 visa status. Insurance requirements are posted at http://graduateschool.vt.edu/igss/maintaining_status/. Medical insurance is mandatory for all College of Veterinary Medicine students at a minimum of \$100,000 accident and sickness coverage. All students in these two areas must show in writing that they have coverage from another insurance company that is equal to or better than the minimum levels required by the university, or they must purchase the university-sponsored student plan. Review of insurance policies is done by the Student Medical Insurance office. <http://www.co.vt.edu/Risk/studenthealthinsr/index.html>

MEDEX Overseas Evacuation Program

An overseas emergency evacuation program is available to faculty, staff, students and their families who may travel overseas either on business or pleasure. MEDEX provides emergency services outside your home country. Included are: locating appropriate medical care evaluation and close monitoring of treatment - management of emergency medical evacuation and transport of mortal remains coordination of direct claims payments to providers verification of your insurance to facilitate hospital admission continuous contact with family, physicians, and employer assistance with interrupted travel plans resulting from an emergency situation assistance replacing lost or stolen medications emergency message transmittal services emergency international transfer of funds assistance in locating lost or stolen passports multilingual language services in emergency situations coordination centers and phone numbers throughout the world MEDEX is already a part of the Virginia Tech medical insurance offered to full-time students attending the university. Students who are not enrolled in VT student insurance may purchase MEDEX Plus evacuation assistance through Risk Management, phone: (540) 231-7439; e-mail: alene@vt.edu. Students should purchase this optional MEDEX coverage prior to leaving the U.S.A. An application form for MEDEX Plus is available on the Risk Management website, http://www.controller.vt.edu/forms/MEDEX_App.pdf. More information about purchasing MEDEX evacuation coverage is available at <http://www.controller.vt.edu/risk/risk2.html#overseas>.

Automobiles and Bicycles

Motor vehicles owned and operated by students who drive them on campus and bicycles must be registered with the University Parking Services Office when the vehicle is brought on campus. Parking information and regulations are available at <http://www.facilities.vt.edu/tcs/parking/>

Graduate Application and Admission

Admission to the Graduate School is contingent upon receipt of a four

year (or 3 year degree recognized by the Bologna process) bachelor's degree from a regionally accredited college or university and the presentation of evidence of potential to pursue graduate work. Additional requirements for graduate degrees, beyond those of the Graduate School, vary across academic units. Prior to submitting an application, individuals are encouraged to review the requirements and conditions for admission. Degrees and their requirements, as well as information about which degrees are offered at non-Blacksburg sites, are available at: http://graduateschool.vt.edu/graduate_catalog/programs.htm. Students currently enrolled for graduate degrees at other universities are usually expected to complete their degree requirements prior to their matriculation at Virginia Tech. Applications for admission are reviewed and evaluated by the departmental Graduate Admissions Committee. Major factors considered in this evaluation are scholastic record, professional experience, letters of recommendation, and as appropriate, scores on standardized tests. Individual departments may have additional admission standards beyond those set by the Graduate School. Applications and all related materials for admission should reach the Graduate School Office at least eight weeks before the beginning of the semester in which enrollment is requested. For financial assistance information, visit <http://www.finaid.vt.edu>. Applications for admission should be submitted on-line at: <https://gradapp.stl.vt.edu/pages/login.php>. If this is not possible, a printable application also is available.

Credentials

Applicants should submit copies of their transcripts with the online application. Unofficial copies are acceptable for review by the department and Graduate School. Upon admission, official transcripts should be sent to the Virginia Tech Graduate School. If the official transcript submitted for admission does not show bachelor's degree completion, the applicant will need to later supply another official transcript showing that the degree has been awarded/conferred. Letters of reference can be submitted on line (preferred) or sent directly to the academic department. Individual departments may require applicants to submit the results of the Graduate Record Examination (GRE). For applicants to the Pamplin College of Business, the Graduate Management Admissions Test (GMAT) is required. Please request that GRE or GMAT scores, if applicable, be sent to Virginia Tech. The Educational Testing Service Institution Code for Virginia Tech is 005859. Please visit academic department websites for other departmental requirements such as resumes, vitas, portfolios, etc. All credentials submitted in support of an application become the property of the university.

International Applicants

Legal Status and Financial Certification All international students must hold valid non-immigrant visa status to enroll at Virginia Tech. Prior to the issuance of certificates of eligibility to apply for the appropriate visa, all international students must submit an Immigration Information Form. The following link provides the Immigration Information Form, Affidavit of Support, and Financial requirements and general instructions: http://graduateschool.vt.edu/forms/international/affidavit_of_support_fillable.pdf. The Immigration Information Form collects (1) information required for issuance of visa eligibility documents and (2) information that demonstrates that a student has sufficient financial resources for at least the first year of education. International students in F-1 and J-1 visa status and their accompanying dependents are required to carry health and accident insurance approved by Virginia Tech. International students who have been admitted and have shown proof of having sufficient funds to cover their educational and living expenses for at least one year are issued visa eligibility documents (I-20 or DS-2019 forms) by

the Graduate School. Evidence of English Proficiency International applicants are exempt from demonstrating English proficiency if they have graduated from an accredited university where English is the language of instruction or if they are U.S. permanent residents ("green card" holders). International applicants may demonstrate English proficiency by submitting scores from the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS). A minimum TOEFL score of 550 paper-based (PBT), 213 computer-based (CBT) or 80 internet-based test (iBT) is required for consideration of the application. On the iBT, subscores of at least 20 on each subtest (Listening, Speaking, Reading, and Writing) are required for admission. A minimum IELTS score of 6.5 is required for admission. Some departments have higher TOEFL or IELTS score requirements than those set by the Graduate School. For more details, see <http://graduateschool.vt.edu/admissions/toefl>. English Placement Test (EPT) All incoming international graduate students are required to take the EPT, a diagnostic writing test, during the orientation period prior to the beginning of classes unless they have a total IELTS score of 7.5 or higher and a writing score of 6.5 or higher or both a TOEFL score of 620 PBT or 260 CBT and an essay writing score (Test of Written English) of 4.5 (out of 6) or higher. On the Internet-Based TOEFL (iBT) a total score of 105 with a writing subscore of 26 (out of 30) or higher is required for exemption from taking the EPT. Those who do not achieve the required scores on the EPT are required to take and satisfactorily complete a semester-long Academic and Professional Writing or Scientific and Technical Writing course during the first semester of their enrollment at Virginia Tech along with their full load of academic classes (9-18 credit hours). There is an additional instructional fee for this course (fee includes the textbooks), taught by the Virginia Tech Language and Culture Institute (LCI; <http://www.lci.vt.edu/elp/>). National Capital Region (NCR) students should consult with the LCI office in that location about alternative sites for any required additional English training. Those at other sites should consult with the Graduate School offices in Blacksburg. SPEAK Test for International Graduate Teaching Assistants (GTAs) International GTAs who are assigned classroom or laboratory teaching duties must pass the TEACH or SPEAK Test before they can begin their teaching duties. For international GTAs to be exempt from oral testing, a minimum Speaking score of 26 on the iBT is required. Those who do not pass the TEACH or SPEAK Test must take English 0014, Oral Communication for International Teaching Assistants (1 Cr.) during the semester prior to beginning their teaching assignment. The TEACH or SPEAK Test is administered individually during the Orientation Period. All GTAs also must attend and be enrolled in the GTA Workshop which begins on the Monday of the week before fall semester classes start in August (see Academic Eligibility to Hold a Graduate Assistantship). Attending at Extended-Campus Locations International students in F-1 or J-1 visa status may pursue graduate degrees in Blacksburg or at the extended-campus in the National Capital Region (NCR). Questions regarding enrollment eligibility at the NCR location should be directed to the International Graduate Student Services office of the Graduate School in NCR at 703/538-3743, GSSONCR@vt.edu; <http://www.ncr.vt.edu/>. Requirements for Assistantships and Employment International students in F-1 or J-1 status who obtained admission into a degree program are eligible for consideration by the academic departments for assistantships and in-state tuition scholarships. Part-time employment on campus is subject to federal regulations governing employment of student (F-1) and exchange visitor (J-1) visa holders. Blacksburg students should contact the International Graduate Student Services office of the Graduate School at 540/231-8486, igss@vt.edu; National Capital Region students should contact 703/538-3743, GSSONCR@vt.edu.

Admission Categories and Graduate Student Classifications

Students are admitted or classified in one of the following categories:

Regular Admission

Regular Admission to a graduate degree is open to an applicant whose grade point average (GPA) meets or exceeds the 3.00 required by the Graduate School for the last half of the credits earned for the undergraduate (bachelors) degree, and whose academic background meets the requirements of the admitting academic unit. A graduate degree, or at least 12 credits of graduate coursework taken post-baccalaureate, while in graduate status, will supersede the undergraduate record in evaluating credentials for admission.

Provisional Admission (Master's only)

Provisional Admission to a graduate degree is open to an applicant whose GPA is below the 3.00 required by the Graduate School, but generally not lower than 2.75, who has other experience or qualifications that demonstrate potential to undertake graduate study, and whose admission is requested by the admitting academic unit. Provisionally admitted students are regular degree-seeking students with the condition that they must earn at least a 3.00 GPA for the first 12 graduate credits they attempt. If a 3.00 GPA is not earned in the first 12 credit hours attempted, the Graduate School will consult with the academic unit to determine whether the student should be allowed to continue for one additional semester on probationary status (see Academic Progress, Probation). Appropriate coursework taken while on Provisional status may be included on the Plan of Study for the student's graduate degree at the discretion of the student's Advisory Committee.

Conditional Admission

An applicant whose academic background is deficient in some aspect, but who otherwise meets minimum GPA qualifications for admission (Regular or Provisional) may be granted "conditional" admission. The admitting academic unit specifies and informs the conditions of admission to the applicant and the Graduate School by letter prior to applicant matriculation. The academic unit notifies the Graduate School when the conditions have been met.

Non-degree Status

Non-degree status is open to an applicant who qualifies for admission to the Graduate School in Regular status (i.e., who has a 3.00 GPA or better for the last 60 credit hours of undergraduate study) but who does not wish to, or cannot be, listed as a degree candidate for one of the following reasons: (a) does not currently desire to work toward a graduate degree; (b) desires to transfer the credits for use toward a graduate degree at another institution; or (c) there currently is no higher degree available at the university other than the one the applicant currently holds in the department or field of study. Official transcripts of the undergraduate degree are required for admission to this status. The university places no limits on the total number of credits that may be taken while in Non-degree status. Credits earned by students in Non-degree status may be used in meeting degree requirements, if they are appropriate for inclusion, in the Plan of Study if the student is later admitted to a graduate degree. Graduate students in Non-degree status are not eligible for graduate assistantships. International Exchange Students in J1 status only may hold Non-degree status for up to two semesters (note that TOEFL score requirements do apply).

Commonwealth Campus Status

Commonwealth Campus status is open to an applicant who holds an

earned bachelors or higher degree from a regionally accredited U.S. university. Examples of students who seek admission into the Commonwealth Campus program include those who (a) may qualify for regular admission but do not currently wish to work for a graduate degree; (b) do not qualify for admission because of a poor undergraduate record and wish to improve their credentials; (c) need to update their academic credentials after several years of professional experience or (d) require graduate courses for professional certification. International students in F1 or J1 visa status are not eligible for Commonwealth Campus status. However, some other types of visa status may allow non-degree enrollment (note that TOEFL or IELTS score requirements do apply). Students applying for Commonwealth Campus status must complete the Application for Admission and submit a transcript (unofficial is sufficient) or a copy of their diploma for the highest degree attained. Students in Commonwealth Campus status are not eligible for graduate assistantships. Commonwealth Campus students are limited to 12 credits of course work while in this status. Students may not earn a graduate degree while enrolled in Commonwealth Campus status. If a Commonwealth Campus student wishes to enter a degree program, the Application for Admission to that degree needs to be filed early in the semester prior to the desired semester for degree entry. If the student is accepted to a degree, a determination of the applicability of any courses taken while in Commonwealth Campus status, to a graduate degree, will be made at the time of submission of the Plan of Study for the degree.

Graduate Certificate Status

A qualified student who wishes to enter Virginia Tech to obtain a graduate certificate, without being enrolled in a degree program, may apply for graduate admission to Graduate Certificate status. Such applicants should submit concurrently an Application for Admission and a Graduate Certificate Application http://graduateschool.vt.edu/forms/academics/certificate_application.pdf. The Graduate School requires a GPA of 3.0 for admission to Certificate Status and official transcripts must be submitted. Note that students pursuing a degree and a certificate simultaneously are classified in their degree program. Credits used toward a certificate may be used in meeting degree requirements if they are appropriate for inclusion on the Plan of Study for the degree.

Visiting Graduate Student Status

A graduate student in good standing at another university may be permitted to take graduate courses by submitting a Visiting Graduate Student Application form, available at http://graduateschool.vt.edu/forms/academics/Application_for_Visiting_Graduate_Student.pdf Enrollment as a visiting graduate student is limited to one calendar year or 18 credit hours.

Eligibility of Faculty/Staff for Graduate Degrees

Teaching and research faculty of the rank of assistant professor or above shall not become candidates for degree or be awarded graduate degrees from this university. The Provost's Office may be requested to waive this policy for an individual following successful appeal to the Commission on Faculty Affairs. Staff and administrative/professional faculty may become candidates for graduate degrees with approval from the academic program, the university employer, and the graduate school. To receive approval, candidates must address conflicts of interest, time, and commitment. Supervisors of these candidates should abstain from chairing and/or serving on the candidates' graduate committees to avoid potential conflicts of interest.

Undergraduates Taking Graduate Courses

Seniors Students in their senior year, with a 3.0 or better GPA, may enroll in 5000-level courses satisfying undergraduate degree requirements within their department with the permission of the course instructor and the Department Head. Should the student become a graduate student, these courses may not be used on the Plan of Study for a graduate degree. Dual Student Status Seniors in a bachelor's degree, who have a GPA of 3.0 or better may be eligible for Dual Status during the final semester of their undergraduate degree. To obtain this status, students must file an application for the master's degree and the Accelerated Undergraduate/Graduate Degree and Course Designation Form (for obtaining Dual Status) (http://graduateschool.vt.edu/forms/academics/Accelerated_Undergraduate_Graduate_Status.pdf). The department reviews the student for master's acceptance and, if this is recommended, indicates on the Admission Analysis form that the student will be accepted for Dual Status for the final semester of the undergraduate degree. This acceptance must occur prior to the final semester of the undergraduate degree. Graduate coursework taken during the semester of dual registration may only be designated for use in the graduate degree when it is not used to meet bachelor's degree requirements (i.e., each course taken during the final semester is specified as being for either the bachelor's or the master's degree). Combined Student Status (Architecture Only) This status is reserved for qualified students in the bachelor of architecture program who: (a) are within 24 semester hours of graduation; (b) are proceeding toward the two-year master's program in architecture; and (c) have at least a 3.0 GPA for the last two years (60 credit hours) of undergraduate studies. Combined students are permitted to take graduate courses. Accelerated Undergraduate/Graduate Degree Programs In accordance with the CGS&P policy for the accelerated undergraduate/graduate degree programs, "each graduate degree program wishing to offer one or more accelerated undergraduate/graduate degree programs must submit a written description of their program to the Graduate School for review and approval before students may be admitted hereto." Consistent with Graduate School policy, the standards for each program must meet the minimum requirements but can exceed these (e.g., GPA, fewer courses to be double counted). These regulations include the following: Students must be accepted into the program prior to the beginning of the semester in which they would enroll in courses to be used on the accelerated program. Students qualifying for the program must be in the last 12 months of their undergraduate degree. Once completion of the undergraduate degree has been verified, students accepted into this accelerated program will be classified as regular graduate students. A maximum of 12 credits of graded coursework may be used in the program. No more than 6 of the double-counted credits may be at the 4000 level; all others must be offered for graduate credit. A grade of B or higher must be earned in each course to be double counted. Courses must not be taken pass-fail if a graded option is available. Programs that intend to accept students into an accelerated graduate program must submit a proposal to the Graduate School that includes the following: Accelerated program(s) to be offered. These can include programs designed for VT students as well as non-VT students from U.S. institutions or in partnership with international institutions. Graduate degrees included - master's or doctoral degrees, or both. Admission criteria and application materials required, including but not necessarily limited to student status, minimum GPA requirement, statement of motivation and career objectives, student's experience and qualifications as reflected in a resume, a portfolio, and/or letters of reference. The number of credits to be double counted towards undergraduate and graduate degrees. Process for identifying potential students and faculty advisors, and for mentoring during program. Tentative listing of courses that the department expects to be used for graduate plans of study for

students in the program. Other conditions or aspects of the proposed program as appropriate.

Enrollment and Registration Procedures

Course Enrollment and Changes in Enrollment

Registration (Course Request; for continuing students occurs during an eight-day period in the middle of each semester during which current students may request and be registered electronically for classes for the next semester. Registration for new students begins prior to the start of the new semester. For registration procedures, see <http://www.registrar.vt.edu/>. Schedule Adjustment Students may adjust their schedules on a space available basis using web DROP/ADD (available through HokieSPA <http://www.hokiespa.vt.edu/>), an electronic schedule adjustment program. The Add Period is restricted to a short period at the beginning the semester, the Drop Period lasts for a larger proportion of the semester; deadlines for these electronic transactions that can be done by the student are published in the Timetable of Classes for each semester, see Important Dates and Registration Information at:

https://banweb.banner.vt.edu/ssb/prod/HZSKVTSC.P_DisRequest. Force-Add A Force-Add form permits enrollment in a class, over the set capacity for that class, within the Add period. This transaction is done with the "force-add" form in the department offering the course, and requires the instructor's (or, in some departments, departmental) permission. Force-adds are processed by the department offering the course during the Add Period in the first week of classes of each semester. Late Adds and Drops Late Adds and Drops: In unusual circumstances when adjustments to the student's schedule are needed after the last date to add or drop a course, permission is required from the instructor, the student's advisor and a graduate dean (see the current Timetable for deadline dates). The request for the Late Add or Drop and an explanation of the extenuating circumstances necessitating the late change should be submitted to the Dean's office by the student's Advisor or the Graduate Program Director of the department. Graduate Withdrawal Course withdrawals late in the semester: If a late withdrawal from a course (after the Drop period for electronic drops) is approved it will be designated as a Graduate Withdrawal (WG on the transcript) and will not carry a grade penalty; this option is only allowed prior to the Friday of the last week of classes for the semester. If a student wants to Withdraw from all courses for the semester or if a student who is enrolled for a single course wants to drop that course, a Resignation/Withdrawal form (see below) must be submitted to the Graduate School for approval and to the Registrar's office by specific deadlines.

http://graduateschool.vt.edu/forms/academics/Graduate_Course_Withdrawal_WG.pdf Resignation/Withdrawal A student may resign/withdraw without academic or tuition penalty by completing an official Virginia Tech Resignation/Withdrawal form on or before the first day of the semester/summer session (see dates on the Timetable for that semester). The form is available at http://www.registrar.vt.edu/documents/resign_withdrawal.pdf. Resignation/withdrawals received at the Registrar's office after 5 pm on the first day of the semester result in partial tuition and fee charges (see Bursar's office refund policy http://www.bursar.vt.edu/refunds/refund_policy.php).

Resignation/withdrawal after the specified date for withdrawing without grade penalty (see Timetable for date for that semester) requires permission of a Graduate Dean and is only permitted because of extenuating circumstances. The student's grade report and transcript will show that he/she was enrolled for the term and that he/she resigned on the specific effective date. Resignation/withdrawals may have

consequences for assistantship and scholarship awards as well as visa status, so these considerations should be investigated prior to completing the forms. Resignation/withdrawals do not affect the student's ability to enroll in the subsequent semester. Student responsibility for enrollment Student responsibility for enrollment. Each student is responsible for verifying his/her enrollment in courses and for making any changes in that enrollment. Students should check their enrollment in specific courses during the first week of classes of a semester (the Add Period) when any corrections can be made electronically. Faculty cannot add or drop students from their rolls and cannot add or drop a student by including or removing his/her name on the final grade sheet.

Continuous Enrollment

Unless on an approved leave of absence, graduate students in degree programs must be registered continuously at VT during the academic year (fall and spring semesters) and pay the prescribed tuition and fees. Students working on research/scholarly activity toward their thesis or dissertation should enroll in the number of credit hours that reflects the extent of a student's study or research activity. The minimum enrollment is for 3 credit hours at VT except in the case of a student who qualifies for Start of Semester Defense Exception. If the student holds a Graduate Assistantship, scholarship or other form of financial support, the enrollment requirement is typically set by the conditions for that support. Students on Graduate Assistantships must be enrolled for a minimum of 12 credits per semester (see Academic Eligibility to Hold a Graduate Assistantship).

Registration at the Time of Examinations and for Degree Completion

Graduate students must be registered at VT for at least the minimum number of credits (3 credit hours) in the semester or summer session when they take an examination required by Graduate School Policies and in the semester when a degree is completed (see Continuous Enrollment). Students who have a thesis/dissertation ready for defense by the beginning of a semester, may schedule that defense early in the semester and qualify for Start of Semester Defense Exception (SSDE, 1 credit); see Start of Semester Defense Exception under Examinations and see Dates for Degree Completion at: http://graduateschool.vt.edu/academics/commencement_deadlines. Students are not required to be enrolled for the purpose of certificate completion alone.

Leave of Absence

Students sometimes experience situations in which they cannot be continuously enrolled. A student may request a Leave of Absence to suspend activities associated with course work or thesis/dissertation research. The Request for Leave of Absence form http://graduateschool.vt.edu/forms/academics/Leave_of_Absence_Request.pdf must be submitted two weeks before the beginning of the semester for which the leave is requested. The leave of absence must be approved by the student's advisor and the Department Head or Graduate Program Director for the department before submission to the Graduate School. If a graduate Dean approves the leave, the continuous enrollment requirement will be relaxed during the period of leave. The Leave of Absence form indicates the time when the student will return to the program and any conditions the department or the Graduate School may stipulate for the student's Readmission within that time. International students should consult the immigration advisors in the Graduate School before taking a leave of absence.

Readmission

When a student has not been registered for more than one calendar year, an Application for Readmission http://graduateschool.vt.edu/forms/academics/Application_for_Readmission.pdf is required whether or not the student has been on a formal Leave of Absence. The Readmission process requires a review of the student's progress and of the Plan of Study to determine what changes, justification of old course work, committee changes or other conditions may be required for readmission to the degree (the forms required for these processes are at: <http://graduateschool.vt.edu/forms/index.html>). The minimum enrollment is 3 credits.

Changes of Status

A change from one type of degree status to another, while remaining in the same major, requires a Change of Status form http://graduateschool.vt.edu/forms/academics/Change_of_Degree_Status.pdf. An example of a status change is: Master's to Ph.D. in the same major. International students in F1 or J1 status should consult with the international advisors in the Graduate School for the proper SEVIS changes. For departments where the non-thesis option is available, a master's degree candidate is allowed to change status from the thesis to the non-thesis option (or vice versa) only once. The Thesis Option Change Form http://graduateschool.vt.edu/forms/academics/Thesis_Option_Change_Request.pdf requires accompanying documentation from the department that verifies the appropriateness of the change of status. A change from Commonwealth Campus or Non-degree status to Master's or Ph.D. requires an Application for Admission and submission of official transcripts (if these weren't previously submitted) and all other required application materials (apply on-line at <http://graduateschool.vt.edu>).

Change of Graduate Program

Change of Graduate Program (between departments) A change from a degree in one graduate program/department to a degree in another program/department requires the approval of the Graduate Program Director or Department Head of both the old and the new programs and the Graduate School. http://graduateschool.vt.edu/forms/academics/Change_of_Graduate_Program.pdf Students wishing to change programs should consult with the department they wish to enter to determine the likelihood of acceptance prior to beginning this process. The department the student wishes to enter may see the original application materials by making a request to the Graduate School and may request additional materials from the student.

Change of Campus

Students who wish to study at a different campus, but remain in the same major, should submit a Change of Campus form http://graduateschool.vt.edu/forms/academics/change_of_campus.pdf International students in F1 or J1 status should consult with the international advisors in the Graduate School for the proper SEVIS changes.

Simultaneous Graduate Degrees

Students wishing to work toward two graduate degrees in different departments/programs should submit an Application for Simultaneous Degree Approval. http://graduateschool.vt.edu/forms/academics/Application_for_Simultaneous_Degree.pdf See also Credit Hour Requirements; Simultaneous Degrees.

General Academic Information

Grading System

Assignment of grades is the responsibility of the course instructor. The university has adopted the following grading system: Letter Grade Numerical Value (GPA) A 4.0 A- 3.7 B+ 3.3 B 3.0 B- 2.7 C+ 2.3 C 2.0 C- 1.7 D+ 1.3 D 1.0 D- 0.7 F 0.0 Grades in all courses, assigned one of the letter grades above, are calculated into the overall GPA on the transcript. An additional GPA is calculated for the Plan of Study for each graduate degree. There are, in addition to the above grades, the following grades that do not calculate into the GPA: "I" (Incomplete), "P" (Pass; performance of C- or higher when enrolled for the P/F grade option), "X" (a temporary grade for the first semester in those courses that continue across more than one semester; "EQ" (Equivalent Credit, a "pass" for research or project/report credit); "RG and RP" (Repeat Graduate grades) and "NR" (grade Not Recorded, indicating the instructor did not enter a grade). The "NG" (No Grade, assigned when the student has not done any of the work for the course) and the grade "F" on a course taken Pass/Fail calculate as 0.0 in computing the GPA.

Grade for Thesis/Dissertation/Major Paper

Research toward a thesis, dissertation or major paper (the last is generally designated as Project and Report credits) is assigned equivalent credit hours (EQ grade) when satisfactory progress has been made. The "NG" grade can be given when progress on a thesis or dissertation has not been satisfactory.

Incomplete, X, NG and NR Grades

An Incomplete ("I") grade, which is not calculated in the GPA, may be given when the requirements of a course have not been completed because of illness or extenuating circumstances. It is at the discretion of the instructor whether the circumstances warrant the assignment of an Incomplete. Incompletes should be removed, by completing the course requirements, as soon as possible. Departments should set policies for the time allowed for removal of "I" grades and the number of "I" grades that are allowed by students in their programs. Grades of "I" may be removed during a period when the student is not enrolled at the university. Grades of "X" are assigned initially to students in a course that extends over more than one semester and are removed when the final grade for the course is entered. Graduate degrees cannot be completed until all "I", "X", "NG" and "NR" grades on the Plan of Study have been converted to a passing letter grade (i.e., a C- or better for courses with the A/F grading option, a P for courses only offered on the P/F grading option). If a student is ready to complete a graduate degree and grades of "I", "X", "NG" or "NR" are present on the transcript but off the Plan of Study, the department should investigate why these grades have not been remedied. In many cases these grades reflect unresolved problems or errors that can and should be remedied. However, as long as the student has a GPA of 3.0 or better both on the Plan of Study and overall, these grades can remain on the transcript and not interfere with degree completion.

Grading System Requirements

All courses taken at Virginia Tech that are included on the Plan of Study, i.e., courses that satisfy degree requirements, must be taken for a letter grade (A/F) except for those courses offered on a pass/fail (P/F) basis only (for example, Independent Study courses and most seminars are only offered P/F). Courses on the Plan of Study with grades below "C-" must be repeated. Courses on the Plan of Study, once taken, cannot be

removed from the Plan of Study. Graduate students are permitted to take additional courses on a pass/fail basis only if those courses are not on their Plan of Study, are outside the department, and are approved by the student's advisor. Such courses may not be used to satisfy minimum degree requirements. Under the graduate P/F grading option, a "P" is granted for earning a "C-" or better in a course. Once credit is received for a course taken P/F, the course may not be repeated under the A/F grading system.

Repeating Courses

Courses originally taken on the P/F option, in which a grade of "F" is earned, may only be repeated on a P/F basis. Courses may not be repeated if a "P" grade is earned, or without permission of the Graduate School if a grade of "C-" or better is earned. When a course is repeated the grade for the earlier enrollment will be a Repeat Graduate ("RG", defined as a grade of "C-" or lower; "RP", defined as a grade of "C" or higher, when the course was first taken) which will not calculate into the GPA. Only the grade earned for the final enrollment in the course will receive a letter grade and be calculated in the GPA. If a student wishes to repeat a course in which the first grade earned was a C- or higher, permission for a policy exception must be obtained from the Dean's office prior to taking the course a second time.

Auditing

An audit requires approval of the instructor. Auditing of laboratory work is not permitted. Registration for Audit may not be changed to credit, or vice versa, after the last day to add classes without an exception to policy by the instructor, the student's major advisor, and the Dean of the Graduate School. An Audit is a mechanism for a student to reserve a seat in a course, with no performance evaluation of the student. If the student or the instructor expects 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. Students are assessed the same rate of tuition and fees for audited courses as for courses taken for credit. Audited courses do not count toward full-time enrollment.

Graduate Credit

Students must have a recognized status with the Graduate School (i.e., have been admitted to graduate studies) and be officially enrolled in a course to earn graduate credit in that course. Graduate courses at Virginia Tech are numbered 5000 or higher. As of Fall 2009 there are no 4000-graduate approved courses (see information about the limited use of undergraduate courses on Plans of Study). Instructors should not allow students to attend if they are not enrolled in a course (i.e., are not on the official Class List, which can be viewed on HokieSpa in Faculty Access, by the end of the Add Period for the semester). Students should resolve all enrollment problems before the end of the Add Period to be able to obtain credit for a course.

On-line Courses/Independent Study in Absentia/Continuing Education

On-line courses offered for graduate credit from accredited universities may be considered for transfer credit (see section on transfer credit limitations in Plan of Study). Independent study (5974) or Graduate Research credits (5994 or 7994) completed while the student is residing at a distance from the instructor's Virginia Tech location must have regular faculty consultation by means such as email or regular telephone calls. No credit toward graduate degrees may be obtained by correspondence study or from continuing education courses.

Academic Progress

GPA Requirements

Students must obtain a 3.00 GPA, both overall and for courses on the Plan of Study. All courses on the approved plan, including supporting courses must be completed with a grade of "C-" or better (see Graduate Degree and Certificate Requirements section below).

Probation due to Unsatisfactory Grades

Students whose cumulative GPA falls below a "B" (3.00 GPA) will be placed on probation by the Graduate School. Enrollment for one semester of probation normally is permitted to remedy an unsatisfactory GPA. If the student does not achieve a 3.0 GPA within one semester after being placed on probation, the Graduate School will consult with the department about dismissal of the student from Graduate School. A department can appeal to the Graduate School for additional time for the student to achieve a 3.0 GPA, providing the student is making reasonable progress in raising the GPA. If an appeal is made to the Graduate School for additional time it should come from the departmental Graduate Program Director or the Department Head. If extra time is granted, the student should be informed in writing of the amount of additional time allowed for achieving a 3.0 GPA. If the department does not support a time extension, the student will be dismissed from the Graduate School.

Satisfactory Progress toward a Graduate Degree

All graduate students are required to have an Annual Review of Progress at least once a year by their Advisory Committees. Students who do not yet have a Plan of Study and an Advisory Committee should be reviewed by the Graduate Program Director or a departmental Graduate Committee. If a student fails to make satisfactory progress toward degree requirements (coursework, grades, research, projects, examinations, and other requirements), permission may be denied to continue in the degree program. This decision may be reached by the student's Advisory Committee, a graduate program Evaluation Committee in the department and the Graduate Program Director, or the Department Head, and recommended to the Graduate School. The Graduate School will dismiss the student for unsatisfactory progress following the recommendation by the department. The departmental recommendation should include documentation of at least one review indicating unsatisfactory progress, communication to the student about what was needed to reestablish satisfactory progress, and evidence that the student's progress continued to be unsatisfactory (second review).

Enrollment Limits and Requirements

Full Time Enrollment

Full-time enrollment for graduate students, for purposes of tuition and fees, consists of a minimum of 9 credit hours during academic year semesters. However, the Commonwealth of Virginia does not count students as full time unless they are enrolled for at least 12 credits, and in most academic contexts, 12 credits is considered full time. The maximum number of credit hours is 18 during academic year semesters. Overloads (19 credit hours or more per semester, or more than 6 per summer session) require permission from a graduate dean.

Graduate Student Employment/Assistantships

Graduate Assistants (GAs, GTAs, and GRAs) must enroll for at least 12

credit hours per semester to be eligible for their assistantship. Students on full assistantship are expected to work an average of 20 work hours per week for the assistantship and are considered to be 50% employed. Graduate students on assistantship can enroll for up to 18 credit hours of course work in academic year semesters and up to 6 credit hours during each summer session.

Virginia Tech Employees

Tuition Waivers or Reimbursement: Full-time salaried employees, who have been admitted to the Graduate School (see the section below on Eligibility of Faculty/Staff for Graduate Degrees), and with the approval of their department, may have waived or reimbursed twelve (12) credit hours per calendar year (Fall through Summer II), not to exceed six (6) credits in a Fall, Spring, Summer I, or Summer II term. Part-time salaried employees are eligible for up to 6 credit hours of tuition waiver per academic year. The maximum number of credit hours will include tuition waiver, tuition reimbursement, or a combination of both. For more information, refer to the Human Resources' website: <http://www.hr.vt.edu/benefits/tuition/>.

Fellowship and Scholarship Recipients

Fellowship and scholarship recipients are required to take at least 12 credit hours each semester in which they are receiving a stipend. These credit hours must represent work toward satisfying minimum degree requirements. Audited courses do not qualify in satisfying this minimum.

Graduate Assistantships

Types of Assistantships

There are three types of graduate assistantships: Graduate Assistant (GA): GAs provide academic and program support to faculty or departments. GA responsibilities may be administrative in nature and consist of duties unrelated directly to teaching or research (such as academic advising, program planning, advising student groups, and assisting with the administration of student services offices). GA responsibilities also may be academic in nature and include grading examinations, problem sets, and/or lab assignments, setting up displays for lectures or laboratory sections, and preparing or maintaining equipment used in laboratory sections. Graduate Teaching Assistant (GTA): GTAs assist faculty in the department in the teaching mission, with assignments including laboratory teaching, grading of examinations, problem sets and/or lab assignments, setting up displays for lectures and laboratory sections, and preparing or maintaining equipment used in laboratory sections. GTAs must have 18 credit hours of graduate-level course work in their teaching discipline to be assigned full responsibility for teaching an undergraduate course. GTAs lacking this training may be assigned to work under the supervision of a faculty member who will be the instructor of record for the course. Graduate students may assist faculty in teaching graduate courses but may not be the instructor of record for the course. GTAs are required to attend and be enrolled in the GTA Workshop (GRAD 5004, 1 cr., P/F) in the first fall semester of their teaching appointment at Virginia Tech. Other students who hope to qualify for a GTA appointment in the future should take the workshop in their first semester at Virginia Tech. The workshop consists of Phase I (two half days, Monday and Tuesday of the week before classes start in August) a wide variety of Phase II sessions during fall semester. Graduate Research Assistant (GRA): GRAs conduct research under the direction of a faculty member, who is typically a principal investigator on an external grant or contract that funds the GRA and determines the nature of research work required for the assistantship. The research work required for the GRA is determined by the funding source and is

typically beyond research done for academic credit toward the student's degree.

Academic Eligibility to Hold a Graduate Assistantship

Assistantships may be offered to degree seeking graduate students admitted to Regular (GPA of 3.0 or greater) or Provisional (GPA of 2.75-2.99) status. To continue to be eligible for an assistantship a student must maintain a GPA of 3.0 or higher and be making satisfactory progress toward attainment of a graduate degree. The academic department and the Graduate School may allow a student to continue on an assistantship for one semester of probationary status to remedy grade deficiencies. Students on assistantships must be enrolled for a minimum of 12 credit hours per academic year semester. Audited courses do not qualify in satisfying this minimum. Graduate students holding assistantships during the academic year and/or in the summer are not required to enroll during summer sessions, except if they are taking a preliminary or final examination.

Additional Employment for Students Holding a Graduate Assistantship

Unless specified otherwise in the assistantship agreement contract, graduate students on full assistantships are not prohibited from seeking additional employment. Students should consult with their academic advisor and/or assistantship supervisor as applicable regarding the fulfillment of their assistantship and graduate study responsibilities. Students must notify the Graduate School about any additional employment agreement, including the period of employment, name and contact of employer, and job title or short description of duties <https://secure.graduateschool.vt.edu/aert/logon.htm>.

Graduate Degree and Certificate Requirements

General Degree Requirements for Graduate Students

For a graduate student, the university degree requirements are those identified in the Graduate Catalog (Policies and Procedures) effective for the academic year in which the student files the Plan of Study. If the requirements will change in the coming academic year (cases where the governance system has set new policy to be effective at the beginning of the next academic year), the graduate student may choose, but is not required, to abide by the "new" requirements. For graduate students not enrolled for more than one calendar year, requirements will be reviewed on a case-by-case basis at the time of Readmission.

Plan of Study

Submission and Approval Submission and Approval. All graduate students must submit a Plan of Study that meets at least the minimum Graduate School requirements for the designated degree. The Plan of Study must be approved by the student's Advisor and Advisory Committee, the Graduate Program Director or Department Head, and the Graduate School. All courses on the Plan of Study, including supporting courses, must be taken on a letter grade (A/F) basis except for those courses approved to be graded on a pass-fail (P/F) basis only. Audit courses cannot be included on the Plan of Study. After approval by the student's Advisory Committee and the Graduate Program Director or Department Head, the Plan of Study should be entered and sent electronically to the Graduate School for approval, according to the following schedule. Master's: The Plan of Study is due by the end of the second academic semester for all Master's degree students (based on full time enrollment of 12 credits per semester). For the Master of Architecture or Master of Urban and Regional Planning

degrees, the Plan of Study is due before 30 credit hours are completed. For Bachelors/Masters students, the Plan of Study is due by the end of the first full semester of graduate study. Ph.D. Ph.D.: The Plan of Study is due by the end of the third academic semester for all doctoral students (based on full time enrollment). Ed.D. Ed.D.: The Plan of Study is due no later than 30 days after the successful completion of the required qualifying examination. The qualifying exam is an Ed.D. requirement, not a Graduate School requirement. Transfer Courses on the Plan of Study Transfer Courses on the Plan of Study. No more than 50% of the graded credit hours needed to satisfy the requirements for a Virginia Tech graduate degree may be transferred in from a regionally accredited university. All such credits must have earned grades of "B" or better, have been earned while in good standing in graduate status, and must have been graduate courses (numbered 5000 or higher) at the institution where the student took the courses. Grades of "S" or "P" are not acceptable for transfer credit. All transfer courses must be acceptable to the student's Advisory Committee and the Graduate Program Director or Department Head. For transfer course work more than five years old, a Justification of 'Old' Course Work form must be filed with the Plan of Study (see below). Credits from other universities are transferred to a Virginia Tech graduate degree at the time the Plan of Study that includes those courses is approved by the Graduate School. Transferred courses count only as credit hours and are not included in the calculation of the Virginia Tech GPA. Official transcripts are required before transfer course work can be approved for the Plan of Study. Research, Project and Report, Practicum or Internship credit hours may not be transferred in from another university to meet Virginia Tech graduate degree requirements (i.e., they cannot be included on the Plan of Study). Credits taken while in undergraduate status or for an undergraduate degree cannot be used as transfer credit for a graduate degree.

Justification of 'Old' Course Work

Justification of 'Old' Course Work. Academic work, including transfer credit more than five years old at the time the Plan of Study is submitted, requires Justification for inclusion on the plan. The Justification form requires an Advisory Committee explanation of how the committee will insure that the student will update their knowledge for out-of-date courses. The Course Justification Request form is at http://graduateschool.vt.edu/forms/academics/Course_Justification_Request.pdf and some procedural guidelines are at <http://graduateschool.vt.edu/academics/pg> Justifications remain valid throughout the degree unless the student is out of enrollment for a period exceeding one calendar year. Justification of "old" course work and review of the Plan of Study occurs at the time of re-admission.

Supporting Courses

Supporting Courses. Supporting courses are those the student's Advisory Committee considers necessary to provide missing background for taking the key courses required for the student's degree program. Courses numbered lower than 4000 can only be used on the Plan of Study as Supporting Courses. All courses listed on the Plan of Study, including Supporting Courses are requirements for the degree and must be completed with a grade of "C" or better. However, supporting courses do not count toward the minimum number of credit hours required for the degree.

Plan of Study Changes

Plan of Study Changes. A Plan of Study Change Form http://graduateschool.vt.edu/forms/academics/Plan_of_Study_Change.pdf is necessary whenever changes are made to the course work on the

Plan of Study. Changes to the Plan of Study must be approved by the student's Advisory Committee, the Department Head or Graduate Program Director and the Graduate School. Once a course on the Plan of Study has been taken for a grade, it must remain on the Plan of Study.

Change of Thesis Option

Change of Thesis Option. A master's degree candidate is allowed to change from the thesis to the non-thesis option (or vice versa) only once. These changes require approval of the Department Head/Graduate Program Director and the Chair of the student's Advisory Committee. Use this form: http://graduateschool.vt.edu/forms/academics/Thesis_Option_Change_Request.pdf. Such changes often require changes in the coursework and Plan of Study.

Grades on Plan of Study Courses

Grades on Plan of Study Courses. All graded courses on the Plan of Study must be taken for a letter grade (A/F) except for those courses offered on a pass/fail (P/F) basis only (for example, Independent Study courses and many seminars are only P/F). Students must maintain a 3.0 GPA or better on the Plan of Study course work. Once a course on the Plan of Study is taken for a grade, it must remain on the Plan of Study.

Repeating Courses on the Plan of Study

Repeating Courses on the Plan of Study. Students are required to repeat any courses on the Plan of Study in which a grade below "C-" has been earned. Courses may not be repeated if a "P" grade is earned or without permission of the Graduate School if a grade of "C-" or better is earned. After a course has been repeated, the grade for the first enrollment will be Repeat Graduate (RG, defined as a "C-" or lower; RP, defined as a grade of "C" or higher when the course was first taken). Only the most recent enrollment in the course will receive a letter grade and be calculated in the GPA.

Graduate Advisory Committees

Committee Functions Committee Functions: The student's Advisory Committee works with the student to design a Plan of Study, approves the Plan of Study, provides advice, conducts required examinations and regularly assesses the student's progress and accomplishments. Advisory Committee members are appointed by the Graduate School on recommendation of the Department Head or Graduate Program Director by submission of a Plan of Study listing the proposed committee members. Committee Size and Composition Committee Size: Master's students must have an advisory committee of at least three faculty members with a Master's degree or higher. Doctoral candidates must have an Advisory Committee of at least four faculty members with a doctoral degree. Requests to expand an Advisory Committee by one member lacking these qualifications may be made to the Dean's office of the Graduate School. Graduate Advisors (Chairs of Advisory Committees) must be teaching/research faculty (full time, tenured or tenure track faculty at Virginia Tech, i.e., Graduate Program Faculty). A department may request that qualified non-tenure track faculty (e.g., Research or Clinical Professors, Professors of Practice, or Emeritus faculty who are research active) be approved as members of the Graduate Program Faculty of a department for purposes of having Chair/Co-chair privileges. Department heads/chairs or Graduate Program Directors may nominate such persons for Graduate Program Faculty status using this form. If the Chair of an Advisory Committee leaves the university or retires during the student's degree, the department should consult with the Dean's Office of the Graduate

School to determine the most appropriate continuing committee composition for advising of the student to degree completion. Committee members on Advisory Committees: Full time, tenure track, teaching/research faculty may serve on graduate committees throughout the university. Committee service by other qualified individuals, inside or outside the university may be requested by the department (see section below). The student should refer to the departmental policies and procedures document for any specific guidelines for graduate Advisory Committee service within the department/program. It is appropriate, but not required, that the Advisory Committee includes at least one faculty member from outside the student's major department. Faculty members are not permitted to serve as Advisor or committee member for family members (spouse or dependent immediate family member), nor for individuals with whom they have a close personal relationship such as partner or extended family member, or a close professional relationship such as business associate or supervisor. A faculty member with a significant financial interest may not serve as sole advisor of a dissertation or thesis committee for a student who is funded through a university sponsored project supported by the advisor's company, or for a student who is employed directly by the faculty member's company. The faculty member with the conflict may serve as co-chair or committee member. If another co-chair is appointed, that faculty member must be of equal or greater rank, must not be involved with the sponsoring company, and must not be subject to undue influence by the faculty-owner. See policy 13010 for a complete description of the disclosures and protections required in such instances. See also Eligibility of Faculty/Staff for Graduate Degrees. Graduate students (including those VT employees who are pursuing graduate degrees) may not serve on a graduate Advisory and/or Examining Committee. Committee Service by Personnel Other Than Tenure Track Teaching/Research Faculty at Virginia Tech Committee Service by Personnel Other Than Tenure Track Teaching/Research Faculty at Virginia Tech: Personnel with suitable academic training and research experience who are not Virginia Tech full time, tenure track or tenured, teaching/research faculty, may be recommended for inclusion on a graduate student Advisory and/or Examining Committee. This category includes personnel from outside Virginia Tech, as well as Administrative/Professional Faculty, Instructors, Adjunct Faculty, Retired or Emeritus Faculty, and Staff at Virginia Tech. Such personnel must have a graduate degree at or above the degree being sought. Approval of the inclusion of such personnel is granted at the time the Plan of Study is approved by the Graduate School. If the person is on a temporary appointment there should be assurance that he/she will be available throughout the student's degree. These personnel may make up no more than one-third of the minimum committee membership, may share thesis/dissertation supervision responsibilities, and enjoy voting rights and privileges. Inclusion of committee members in these categories is requested by the student's Advisory Committee Chair and Graduate Program Director using the form found at http://www.graduateschool.vt.edu/forms/academics/Grad_Progr_Fac_Ad_Members.doc. A curriculum vitae for the proposed committee member should be included with the form and the particular advantages of including this person on the committee should be cited. Once the registration form has been filed for an individual, a new form is not required for service on additional committees. Before submitting a registration request, check the list of approved Graduate Program Faculty and Additional Committee Members at <https://secure.graduateschool.vt.edu/apf.html> Changes in a Student's Advisory Committee Changes in a Student's Advisory Committee: will be granted only on approval of all committee members, new and old, and on recommendation by the Department Head or Graduate Program Director [Advisor.pdf In the case that one or more members does not approve the change in the membership of the Advisory Committee, an appeal may be made by either the student or a faculty member to the Department Head. If the Department Head considers the appeal to have merit, he/she may then ask the Graduate School for an exception to all members signing the form.](http://graduateschool.vt.edu/forms/academics/Change_of_Committee-</p></div><div data-bbox=)

Scholarly Ethics and Integrity

All graduate students are expected to uphold the Virginia Tech Principles of Community and the Graduate School's Expectations for Graduate Education as well as the scholarly integrity and research ethics standards of their disciplines. Graduate students must complete degree program requirements for learning about 4 required scholarly ethics and integrity topics plus additional topics relevant to the discipline as follows. Required topics :1. Plagiarism and other violations of the Graduate Honor Code2. Proper use of professional conventions in citation of existing research and scholarship, accurate reporting and ownership of findings, and acknowledgement of contributions to the work3. Ethical standards in teaching, mentoring, and professional activities4. Available avenues for reporting alleged misconduct Additional topics, as relevant to the discipline :1. Appropriate lab procedures and maintenance of lab notebooks and other research documentation2. Fair use of publications, software, and equipment3. Appropriate research protocols involving human and animal subjects; Institutional Review Board and/or Institutional Animal Care and Use Committee certification4. Guidelines for maintenance of confidentiality (and, where relevant, anonymity) in research5. Guidelines for determination of authorship6. Appropriate grant and contract management, including appropriately asserting personal or program capacities and competencies when applying for grants and contracts7. Discipline or fieldspecific professional ethics

Credit Hour Requirements for Degrees and Certificates

Master's Degree

Virginia Tech allows for both thesis and non-thesis master's degrees. For each degree type, the student's Plan of Study must meet the semester credit hours requirements shown below. Departments/programs may have additional requirements and an advisory committee may add specific requirements needed for an individual student's academic development. Graded credits must be taken for an A/F grade unless the course is only offered P/F (see Grading System Requirements). See Transfer Credit for policies about the transfer of graduate credits for use on the Plan of Study. See Undergraduates taking Graduate Courses for policies allowing Bachelor/Master's students at Virginia Tech to transfer some courses from the bachelor's degree to the master's degree (also referred to as double counting courses toward both degrees). Thesis Master's Minimum total credits: 30 credit hours Minimum graded credits: 20 credit hours May include a maximum of 6 credits of Virginia Tech 4000-level undergraduate course work The 6 credits of Virginia Tech 4000-level course work may include Special Study (4984) courses but may not include Undergraduate Independent Study (4974) or Undergraduate Research (4994) courses. All other graded course work must be 5000 level or higher (i.e., graduate course work) The 5000-level course work may include a maximum of 6 credits total in 5974, 5984, and 6984 courses and 3 credits of seminar. Minimum research credits: 6 credit hours of Master's Research (5994) taken at Virginia Tech. Non-thesis Master's Minimum total credits: 30 credit hours Minimum graded credits: 24 credit hours May include a maximum of 6 credits of Virginia Tech 4000-level undergraduate course work The 6 credits of Virginia Tech 4000-level course work may include Special Study (4984) courses but

may not include Undergraduate Independent Study (4974) or Undergraduate Research (4994) courses. All other graded course work must be 5000 level or higher (i.e., graduate course work) The 5000-level course work may include a maximum of 9 credits total in 5974, 5984, and 6984 courses and 3 credits of seminar. Maximum project and report or research credits: May include a maximum of 6 credits of Project and Report (5904) credits taken at Virginia Tech

Second Master's Degree

Second Master's Degree (both degrees at Virginia Tech). The requirements for a second master's degree (after the first master's has been completed) are the same as for the first master's degree: an additional 30-54 hours, depending on the degree sought. No more than 50% of appropriate graded course work, to meet the requirements for a master's degree, may be common to both degrees. For example, if one master's degree requires 20 credits of graded coursework and the other requires 30 credits of graded coursework, no more than 10 credits (50% of the graded work on the degree with lower graded credit requirements) can be used toward both degrees. No Research or Project and Report credits from the first master's degree can be used for the second master's degree. If the first master's degree is from another university, see Transfer Credits.

Simultaneous Degrees

If a student wishes to pursue two graduate degrees in different departments simultaneously, an Application for Simultaneous Degree must be submitted

http://graduateschool.vt.edu/forms/academics/simultaneous_degree.pdf.

No more than 50% of appropriate graded course work requirements for a master's degree may be common to both degrees. For example, if one master's degree requires 20 credits of graded coursework and the other degree requires 30 credits of graded coursework, no more than 10 credits (50% of the graded work on the degree with lower credit requirements) can be used toward both degrees. No Research or Project and Report credits from one degree may be counted toward the other degree.

Education Specialist Degree (Ed. S.)

The Education Specialist Degree (Ed.S.) is a post-master's program requiring 60 credit hours. The program consists of 30 credit hours (minimum) from Virginia Tech and up to 30 credit hours of transfer credit from the master's degree. At least 21 credit hours must be completed at Virginia Tech after acceptance into the Ed.S. degree program. In this program, candidates are expected to attain a broad and systematic understanding of professional education, a definitive knowledge of a particular field of specialization and the ability to integrate and apply theoretical concepts of education in an actual educational context. This graduate program is designed for the accomplished, experienced practitioner with special professional aspirations beyond the masters, but who generally does not wish to pursue a doctorate. The Ed.S. is designed to meet this need and is offered in several specialty areas.

Doctoral Degrees

Doctor of Philosophy (Ph.D.) Doctoral degrees at Virginia Tech must meet the semester credit hour requirements listed below and include a dissertation that involves original research/scholarship.

Departments/programs may have additional requirements and an advisory committee may add specific requirements needed for an individual student's academic development. Graded course work on the Plan of Study must be taken for an A/F grade unless the course is only offered P/F (see Grading System Requirements). Students can apply

graded coursework credits taken at Virginia Tech for a master's degree at Virginia Tech to a doctoral plan of study in the same program area if the Advisory Committee considers the courses appropriate for the doctoral degree. No Research and Thesis or Project and Report credits from a master's degree can be used for a doctoral plan of study. See Transfer Credit for policies about the transfer of graduate credits for use on the Plan of Study. Minimum total credits: 90 credit hours Minimum graded credits: 27 credit hours The Plan of Study may include a maximum of 6 credits of Virginia Tech graded 4000-level undergraduate course work. The 6 credits of Virginia Tech 4000 level course work may include Special Study (4984) courses but may not include Undergraduate Independent Study (4974) or Undergraduate Research (4994) courses. All other graded credits must be at the 5000 level or higher (i.e., graduate course work). Some departments have approval from the Commission on Graduate Studies and Policies to reduce the minimum number of graded course work credits required for a specific degree program. See departmental degree requirements to determine if a department has approval for such changes in requirements. The 5000-level course work may include a maximum 18 credits total in 5974, 5984, and 6984 courses and 4 credits of seminar. Minimum research credits: 30 credit hours of Doctoral Research (7994). Doctor of Education (Ed.D.) The Graduate School course work requirements for the Ed.D. are the same as those listed above for the Ph.D. with the exception that the minimum number of Research and Dissertation 7994 credits is 24. The dissertation for the Ed.D. typically demonstrates the candidate's ability to investigate phenomena in educational institutions or service agencies to increase practitioners' understanding of practical problems and issues.

Residency Requirements for Doctoral Degrees

Doctoral Degrees Virginia Tech offers three doctoral degrees: the Doctor of Philosophy (PhD), the Doctor of Education (EdD) and the Doctor of Veterinary Medicine (DVM). The PhD and EdD degrees are offered through the Graduate School and the DVM is offered through the College of Veterinary Medicine. The PhD is a research degree that focuses on "basic research that expands the knowledge base of the field" while the EdD is focused more on "applied research related to professional practice" (Council of Graduate Schools, CGS, 2005). The nature and purpose of the PhD is described as the following (CGS, 2005): "The Doctor of Philosophy program is designed to prepare a student become a scholar: that is, to discover, integrate, and apply knowledge, as well as to communicate and disseminate it. Such skills may lead to careers in social, governmental, educational, biomedical, business, and industrial organizations as well as in university and college teaching, research and administration. The PhD. Program emphasizes the development of the student's capacity to make significant original contributions to knowledge in a context of freedom of inquiry and expression. A well-prepared doctoral student will have the ability to understand and critically evaluate the literature of the field and to apply appropriate principles and procedures to the recognition, evaluation, interpretation and understanding of issues and problems at the frontiers of knowledge. The student also will have an appropriate awareness of and commitment to the ethical practices appropriate to the field." (p. 1) In accordance with the definition of doctoral degrees as involving mastery of intellectual principles, development of original scholarly contributions to the chosen field or fields, and critical evaluation of issues and problems in relevant disciplines, residency is required for all doctoral students at Virginia Tech. Doctoral Residency Guidelines Residency allows students to concentrate focused time on their degree, acquire the necessary "habits, attitudes, skills, and insights" (CGS, 2005) required for contributions to scholarship, and have opportunities to work closely with other scholars including faculty and other graduate students. These scholarly skills, attitudes, and experiences go beyond

acquiring knowledge in classes and beyond experience in professional practice. The Graduate School expects all graduate programs to encourage and provide opportunities for immersion of doctoral students in scholarship. Residency goals can be achieved by multiple means, including but not limited to individual and group research training; providing access to resources such as libraries, research equipment, scholarly materials, and laboratories; providing networking opportunities with Virginia Tech and external scholars and graduate students; participation in scholarly seminars presented by scholars from Virginia Tech or elsewhere; assisting with developing applications for external funding of scholarly endeavors; participation at scholarly conferences; and publications or other forms of scholarly dissemination. Residency for doctoral degree programs (PhD, EdD) can be accomplished through one of three mechanisms. Two consecutive semesters of full-time enrollment: Programs will be expected to provide opportunities during those two semesters to cultivate immersion in scholarship and achieve the goals of residency. Students completing residency via full-time enrollment should understand residency goals and plan not only to complete required courses, but also to sustain scholarly engagement and immersion in research, scholarship and professional development. Program-specific alternative residency plan: Academic degree programs may propose alternative methods by which enrolled students will achieve residency goals to be approved by the Graduate School. Program-specific alternatives may be proposed for doctoral degree programs offered outside Blacksburg or on the Blacksburg campus. Individual alternative residency plan: Proposals for alternative residency from individual students can be submitted for approval by the Graduate School. Each academic degree unit should determine the mechanism through which the doctoral students can satisfy the residency requirement. Academic units may utilize any or all of the three options as determined appropriate by the graduate program faculty. For existing degree programs, the enrollment-based requirement will serve as the mechanism unless a specific request is made for a program-specific alternative residency plan. For new degree programs, the mechanism for earning doctoral residency should be included in the proposal submitted for approval through the governance process. Proposals for alternative residency plans (program-specific, individual) should include a description of how the alternative plan will help achieve the purposes and goals of doctoral residency: Please provide strategies for each of the following goals: Disciplinary depth and breadth Access to a wide variety of classes and academic experiences in the student's field and in related disciplines Access to library, information technology, and laboratory resources Quality and rigor of the program through involvement with and scrutiny by peers in other disciplines Scholarly immersion Development of the student's capacity to make significant original contributions to knowledge in a context of freedom of inquiry and expression (e.g., individual and group research training, assisting with developing applications for external funding, participation at scholarly conferences, publications or other forms of scholarly dissemination). Ability to understand and critically evaluate the literature of the field and to apply appropriate principles and procedures to the recognition, evaluation, interpretation and understanding of issues and problems at the frontiers of knowledge. Professional socialization Substantial interaction with a large pool of faculty to obtain scholarly and disciplinary advice, perspective, and guidance Interaction with fellow graduate students on professional issues Provision of a broad range of professional development experiences to guard against over-specialization Access to a wide spectrum of seminars, professional presentations, and contact with leaders in their own discipline as well as others Professional practice Awareness of and commitment to the ethical and regulatory principles and practices appropriate to the field. Program-specific alternative residency proposals should clearly identify the various methods the program will utilize to promote scholarly

immersion and achieve the goals of residency as discussed above. The plan should consider the goals of residency and outline the ways these will be achieved, including specific activities and the timeframe as appropriate during which residency will be completed. Program-specific alternative residency plans should be submitted by the academic unit to the Graduate Dean for review and approval. Proposals should be submitted at least one semester before the desired effective date for implementation. Proposals will be reviewed and feedback provided within 30 days of submission. As needed, initial proposals can be revised for final review and approval. In addition, programs can submit revised or updated plans if elements of the degree program change. Individual alternative residency proposals must be submitted by the student and faculty advisor/committee as appropriate to the Graduate School for review and approval. Students should begin planning with their advisors early in their degree programs. Individual alternative residency plans must be submitted to the Graduate School as early as possible or at the latest, concurrent with submission of the Plan of Study. Alternative residency will be approved by the Graduate Dean before approval of the Plan of Study Recording of residency plans: All doctoral students should indicate the mechanisms by which they plan to earn residency on the Plan of Study form. Should a change in residency plan be required, students can seek approval of such change via the Plan of Study Change form accompanied by relevant documentation. Second Doctoral Degree A student who is seeking a second doctoral degree, regardless of whether the first was earned at this university, must earn a minimum of 48 additional semester credits and must satisfy the residency requirements specified for the doctoral degree at Virginia Tech.

Graduate Certificates

Graduate certificates can be awarded to individuals who do not desire to work toward a degree as well as to students who are working on graduate degrees. Of the graduate course work (5000-level or higher courses) for the certificate, at least 2/3 must be graded course work taken on the A/F grading option. Certificates must include a minimum of 9 credit hours of Virginia Tech graduate course work credits. No transfer credits can be applied to graduate certificates. All grades for certificate courses must be "C" or higher and the overall certificate GPA must be 3.0 or higher. The specific requirements for each certificate can be found on the Graduate School Certificate Page:

http://graduateschool.vt.edu/graduate_catalog/certificates.htm.

Certificate candidates must be admitted to the Graduate School and formally accepted to the certificate program:

<http://graduateschool.vt.edu/admissions/applying/index.html> Upon successful completion of certificate requirements, an Application For Certificate Conferral

http://graduateschool.vt.edu/forms/academics/Application_for_Degree_or_Certificate.pdf must be signed by the department and submitted by the Application for Degree deadline in the term in which the certificate will be awarded. Meeting this deadline is necessary for the student's name to appear in the commencement bulletin.

http://graduateschool.vt.edu/academics/commencement_deadlines

Examinations

All graduate examinations are open to the faculty and faculty members are encouraged to attend and participate in such meetings. The student must be registered during the semester in which any examination required by Graduate School Policies is taken.

Scheduling Examinations

Scheduling Examinations: Examinations required by Graduate Policies

and Procedures (Preliminary and Final Examinations), are scheduled through the Graduate School. https://gradexam.stl.vt.edu/http://graduateschool.vt.edu/forms/academics/Request_to_Admit_Candidate_to_Prelim_Exam.pdf Requests to schedule examinations must include the time, date, building and room number, title of dissertation or thesis, and the names and signatures of the Examining Committee. These requests are due in the Graduate School at least two weeks before the examination date requested. Notification of the approval of the examination scheduling and the examination form/card will be sent electronically to the student and all members of the Examining Committee. The examination should not be conducted if the Advisor has not received notification that the examination has been scheduled and the examination form/card has been received. The preliminary examination card should be returned to the Graduate School within 2 days after the examination, with each committee member signifying whether the exam performance was Satisfactory or Unsatisfactory. The final examination result should be entered in the Electronic Signature System within 2 days after the examination, with each committee member signifying whether the exam performance was Satisfactory or Unsatisfactory. Preliminary examinations and non-thesis final examinations can be scheduled through the last day of exams for the term. Final examinations for master's thesis and doctoral students must be scheduled early enough in the term to meet the final ETD submission date. Before filing the request for scheduling an examination, the student's record should be reviewed by the department to make sure that the Plan of Study has been filed and approved and that there are no problems. The Graduate Program Director's signature on the form is the departmental verification that the Plan of Study has been examined and that it is appropriate for the student to schedule the examination. For Preliminary Examinations, which commonly are comprehensive examinations of the doctoral coursework, typically students complete the formal coursework on the Plan of Study prior to taking the exam. If a student has coursework remaining to be taken, the department should determine whether or not it is appropriate for the student to take the examination before all the graded coursework on the Plan of Study is completed. Students may take the Preliminary Examination despite having some grade problems on the Plan of Study (e.g., Incompletes, grades <C- that require retaking a course) but the student's Advisory Committee should address whether this will put the student at a disadvantage on the exam. If the decision is to schedule the exam in a case like this, a note addressing the committee's decision to move forward with the exam should accompany the exam request. By the end of the degree, all grades on the Plan of Study must be a C- or higher and the Plan of Study and overall GPA must be 3.0 or higher. For scheduling of the Final Examination, Thesis Master's and Ph.D. students must have the thesis/dissertation ready for defense (as judged by Advisory Committee members having read the document and signed the examination scheduling request) and the student must be able to complete all other degree requirements within the semester when the examination is held: all coursework on the Plan of Study will need to be completed with grades of C- or higher and both the Plan of Study GPA and the overall GPA must be a 3.0 or higher by the end of the semester. Because some of the problem situations with deficient grades or credits require retaking courses or adding credits, the Plan of Study should be examined at the beginning of the semester in which a student plans to take the Final Examination. For Non-thesis Master's students, scheduling of the Final Examination requires that the student will be able to complete any Project and Report or Independent Study requirements, complete all coursework on the Plan of Study with grades of C- or higher and attain a Plan of Study and overall GPA of 3.0 or higher by the end of the semester. Students wishing to schedule the Final Examination, who have not been enrolled at Virginia Tech for more than a year, need to file for Readmission and allow enough time for any problems to be resolved

so they can be Readmitted prior to the 2 week period needed for Exam scheduling. The minimum enrollment is 3 cr. For enrollment requirements when taking a Final Examination, see below. Required examinations are administered during regular academic semesters or sessions, i.e., between the first day of classes for a given semester or session and ending with the last official day for examinations. Permission to schedule an examination in the time between sessions may be granted if an explanation of special circumstances requiring that scheduling is made to the Dean's office of the Graduate School by the student's Advisor. Scheduling of examinations between semesters/terms does not alter ETD submission or approval deadlines.

Examining Committees

At least four scholars eligible to serve are required to participate on every doctoral Advisory Committee, and at least three are required for every master's Advisory Committee. All members of a student's Advisory Committee are required to participate in that student's doctoral (preliminary and final) or master's (final) examinations. If one of the Advisory Committee members cannot participate, the committee member should recommend to the Chair of the Advisory Committee, when possible, the name of a scholar eligible for advisory committee membership to serve as a proxy on the Examining Committee. After consultation with the student, the Chair of the Advisory Committee makes such a proxy appointment in writing. Regardless of the size of the size of the Committee, only one official proxy will be approved. Those conducting the preliminary examination must all sign the preliminary examination card indicating whether they consider the student's performance to be Satisfactory or Unsatisfactory. If an examination participant is at a remote location, that person may send an email message giving permission for the Chair of the Advisory Committee to sign on her or his behalf. The preliminary examination card should be returned to the Graduate School within 2 days after the exam. Those conducting the final examination must log in to the Electronic Signature System and enter their decision on the exam result. The proxy must communicate with the committee member for whom he or she is serving as a proxy regarding the exam result decision and the original committee member must log in to the Electronic Signature System and enter the decision. All committee members must also signify approval or disapproval of the thesis/dissertation in the Electronic Signature System. This signifies that the thesis or dissertation is in final form and ready for ETD submission to the Graduate School.

Successful Completion of Required Examinations

To pass any of the required examinations, a graduate student is allowed at most one Unsatisfactory vote. If a student fails an examination, one full semester (a minimum of 15 weeks) must elapse before the second examination is scheduled. Not more than two opportunities to pass any one examination are allowed. A student failing any of the examinations required by Graduate Policies two times will be dismissed from graduate studies by the Graduate School.

Final Examination (Master's)

An oral and/or written final examination is required of all master's programs (see departmental policy for specific format). For some non-thesis master's programs, final exams are structured in special ways and in some non-thesis master's degrees the evaluation of a project is used in lieu of a final examination. For more information about master's final examinations, consult the departmental policies and procedures document. <https://gradexam.stl.vt.edu/>

Qualifying Examination (Doctoral)

Certain departments require doctoral students to take a qualifying examination (see departmental policies). The results typically are used to evaluate subject mastery, to determine deficiencies, and to determine whether the student should continue into dissertation research. The results of qualifying examinations are made part of the student's departmental record. Qualifying examinations are not scheduled through the Graduate School.

Preliminary Examination (Doctoral)

The Preliminary Examination is a requirement for all doctoral students. This examination must be taken at least 6 months before the Final Examination. The Preliminary Examination may be oral or written, or both

http://graduateschool.vt.edu/forms/academics/Request_to_Admit_Candidate_to_Prelim_Exam.pdf. Individual departments may choose to administer the Preliminary Examination as a written departmental examination for a group of doctoral students. In this case the examination is typically administered by a committee with all members certifying the results to the department. If an Advisory Committee member cannot participate, the committee member should recommend to the Chair of the Advisory Committee, when possible, the name of a scholar eligible for advisory committee membership to serve as a proxy during the examination. After consultation with the student, the Chair of the Advisory Committee makes such a proxy appointment in writing. Regardless of the size of the size of the Committee, only one official proxy will be approved. The examination date requested should coincide with the date when the decision about the student's performance is made. The results should be reported to the Graduate School within 1-2 days of the decision about the examination. If a department conducts the Preliminary Examination as a departmental examination, the members of the individual student's Advisory Committee, including a proxy, must sign the examination card. If the Preliminary Examination consists of a written section followed by an oral examination, the examination date requested should be the date of the oral.

Final Examination (Doctoral)

All doctoral candidates must take a final oral and/or written examination, which is at minimum a defense of the dissertation. See Advisory Committee Approval of Thesis or Dissertation for a full explanation. This examination must be scheduled no earlier than six months after successful completion of the preliminary examination. <https://gradexam.stl.vt.edu/> To be eligible for hooding at Commencement, the Final Examination must be completed and the Electronic Thesis/Dissertation (ETD) must be approved by the Graduate School by the published deadline for the semester: http://graduateschool.vt.edu/academics/commencement_deadlines

Enrollment and Examinations

Enrollment and Examinations The minimum enrollment for students working on writing their thesis/dissertation (including consulting with their advisor and/or committee during a semester or summer session) is 3 credit hours. Graduate students must be enrolled for the minimum number of credits in the semester or summer session in which they take an exam and in the semester in which they complete a degree: 3 credit hours during a semester or summer session 1 credit hour for students who qualify for Start of Semester Defense Exception (SSDE, see below) in the semester of their final exam Qualifying for Start of Semester Defense Exception Start of Semester Defense Exception (SSDE) is a special enrollment category for students who have fulfilled all requirements, including advisory committee review and agreement that the thesis or dissertation is ready for defense, and are registering only to

take the final oral examination. To qualify for start of semester defense exception, a student must have: completed all requirements (including passing grades on all courses on the plan of study), except for the final exam and submitted the final copy of the thesis/dissertation to the advisory committee within the first three weeks of the semester and at least two weeks before the defense and received permission from the advisory committee, who have read the document and consider it ready for defense (to the extent that the student can make corrections and submit the ETD within two weeks of the defense) within the first three weeks of the semester and been enrolled in at least three credit hours the preceding semester and submitted the SSDE form to the Graduate School by the Friday of the third week of classes or no later than three weeks prior to the defense, whichever date comes first Scheduling a Final Exam within the Start of Semester Defense Exception Timeline To defend under SSDE, a student must schedule and attend the defense according to the following timeline: Within the first three weeks of the semester: Submit SSDE form to the Graduate School Wait for the Graduate School to enroll student in 1 cr (students cannot enroll themselves) Submit Application for Degree in HokieSPA Submit Request for Final Examination (at least two weeks prior to the exam date) in the Electronic Signature System Within the first five weeks of the semester:

International students who qualify for SSDE must defend (complete final exam) to maintain immigration status. Understanding Potential Implications of Start of Semester Defense Exception If a student registers for SSDE, his/her enrollment status will be less than full time, which may affect the following: financial aid or loan deferments employment opportunities (not eligible for assistantships or fellowships) visa status (for international students) Students should consult with the Graduate School and/or Office of Scholarships and Financial Aid to understand the consequences and additional requirements that may result from enrolling under start of semester defense exception.

Thesis and Dissertation

Master's degrees

Master's degrees may be thesis or non-thesis and this is specified on the Plan of Study at the time the plan is submitted. For departments where the non-thesis option is available, a master's degree candidate is allowed to change from the thesis to the non-thesis option (or vice versa) only once. A change between thesis and non-thesis requires the filing of a Thesis Option Change form

http://graduateschool.vt.edu/forms/academics/Thesis_Option_Change_Request.pdf

Doctoral degrees

Doctoral degrees (Ph.D. and Ed.D.) require a dissertation that involves original research.

Independent Effort

Two or more students may work on the same total problem; however, each student must prepare an independent thesis or dissertation on that student's part of the problem. The individual contributions of each student involved in the same problem should be explained in each thesis or dissertation.

Dissertation Format

Dissertations may be prepared in the traditional multi-chapter format or in manuscript format (minimum of two journal articles, plus front and back matter as indicated in the guidelines).

<http://etd.lib.vt.edu/etdformats.html>

Proprietary or Classified Theses and Dissertations

In certain instances a portion of students' thesis or dissertation research might involve proprietary, controlled, or classified information. Although some results might need to be summarized for the sponsor in a separate embargoed document, a completely embargoed thesis or dissertation conflicts with scholarly values of peer review and promotion of knowledge and should be avoided. All theses and dissertations produced to meet Virginia Tech degree requirements should be subject to an open defense and open publication (including ETD submission), and capable of standing as academically-complete works. Since any proprietary or governmental restrictions should be known at the outset, students are expected to seek a pre-research review of their thesis or dissertation plans with the sponsor whenever there is a possibility that certain findings might be subject to embargo. In coordination with the Chair of their Advisory Committees, students should communicate to the Graduate School as soon as possible any anticipated restrictions on their research. Similarly, a pre-publication review should be conducted with the sponsor as early as is prudent to identify any restrictions on publication, including acceptable separation of restricted findings into an embargoed document. Any publication restrictions should be communicated to the Graduate School as soon as they are known or predicted.

Advisory Committee Approval of the Thesis or Dissertation

All members of a student's Advisory Committee are required to participate in that student's final examination. Depending upon the technological resources available, committee members may participate from a remote location. If an Advisory Committee member cannot participate, the committee member should recommend to the Chair of the Advisory Committee, when possible, the name of a scholar eligible for advisory committee membership to serve as a proxy during the examination. After consultation with the student, the Chair makes such a proxy appointment in writing. Regardless of the size of the advisory committee, only one official proxy will be approved. Those conducting the examination must log in to the Electronic Signature System and enter in their decision on the exam result. The proxy must communicate with the committee member for whom he or she is serving as a proxy regarding the exam result decision, and the original committee member must log in to the Electronic Signature System to enter the decision on behalf of the proxy. All committee members must also signify approval or disapproval of the thesis/dissertation in the Electronic Signature System. This signifies that the thesis or dissertation is in final form and ready for ETD submission to the Graduate School. If a committee member does not approve the thesis/dissertation, that non-approval will be designated on the ETD. A successful candidate is allowed, at most, one negative vote, regardless of the size of the Advisory Committee.

Electronic Thesis and Dissertation (ETD)

Theses and dissertations are submitted electronically. For instructions, see <https://secure.graduateschool.vt.edu/GSITWiki/Wiki.jsp?page=GAAPSETD>

Deadline for ETD Submission

The final version of the thesis or dissertation approved by the student's Advisory Committee must be submitted electronically as an ETD to the Graduate School no later than two weeks after successful completion of the final examination. The ETD Approval Form, indicating Advisory Committee approval of the document must be returned to the Graduate School when the ETD is submitted. If the process of ETD revisions

leading to Graduate School approval of the ETD extends beyond the posted deadlines for a semester, the student will be enrolled for 1 credit of SSDE in the later semester when degree completion occurs. http://graduateschool.vt.edu/academics/commencement_deadlines

Degree Completion and Graduate School Approval of the ETD

Degree Completion Graduate degrees are completed after the approval of the ETD by the Graduate School and the completion of all other requirements for the degree.

Copyrighting and Microform

The Graduate School does not require students to register their copyright. ProQuest (previously University Microfilms), digitizes abstracts in their book Dissertation Abstracts and also digitizes the dissertations <http://il.proquest.com/brand/umi.shtml> If a master's student wishes to register the copyright, they must apply directly through the Library of Congress Copyright Registration Office. More information concerning the requirements and cost of copyright registration can be found at <http://copyright.gov/eco/>

Intellectual Property

A University Intellectual Property Policy was adopted in 1986 by the university's Board of Visitors. The policy applies to copyrightable material, patentable inventions, and other creations conceived by any faculty member, staff member, or student employee when substantial university resources, such as money or equipment, are used in connection with the conception and/or development of the creation. All such creations are the property of the university and subject to any applicable agreements with funding agencies. If a student employee has conceived a creation, which may belong to the university pursuant to the Intellectual Property Policy, it is his or her responsibility to report promptly the creation to the university. All creations must be reported to the Office of the Vice President for Research. Creations must be reported before publication of the item, or before publication of information relative thereto or before disclosure to an outside firm or agency. Under the existing policy, net income to the university in the form of royalties (etc.) from the creation may be shared equally with the creator(s). Copies of the Intellectual Property Policy and assistance in reporting creations may be obtained from the Office of the Vice President for Research <http://www.research.vt.edu/> or <http://www.vtip.org/>

Graduation

Procedures for Graduation

Students anticipating degree completion or certificate award must file an Application for Degree (AFD) form http://graduateschool.vt.edu/forms/academics/Application_for_Degree_or_Certificate.pdf or an Application For Certificate Conferral http://graduateschool.vt.edu/forms/academics/Application_for_Degree_or_Certificate.pdf to obtain a diploma or certificate and to have their names appear in the Commencement Bulletin. Submit two forms if receiving both a degree and a certificate. The AFD should be submitted electronically through Hokie SPA. Schedules for those wishing to complete their degrees in time to attend Commencement are posted at http://graduateschool.vt.edu/academics/commencement_deadlines

Graduation Clearance Procedures

Summary of Procedures Summary of Procedures for a candidate for the master's or doctorate degree: 1. Students must be enrolled at Virginia

Tech in the term in which the degree is awarded. 2. Filing of Application for Degree, payment of fee. This form makes an individual degree completion checklist available to the student on Hokie SPA. It must be submitted prior to the last day of classes of the term in which the student intends to graduate. 3. Submission of the Request to Schedule Final Examination, two weeks before the proposed examination date for students who have been enrolled during the last year. For those who have been out of residence for more than a year, and require Readmission, the Readmission process should be completed before requesting the Final Examination. 4. Taking Final Examination. 5. Submitting the final version of the thesis or dissertation, approved by the student's Advisory Committee through the Electronic Signature System, as an Electronic Dissertation or Thesis (ETD) within two weeks after the defense. 6. Submitting any applicable supporting documentation for the ETD (e.g., copyright permission letters to reproduce items from other publications, Institutional Research Board approval or exemption notices (if appropriate), UMI form, Survey of Earned Doctorates). 7. Payment of the archiving fee which is required of students at the time the ETD is submitted. 8. Degree Completion requires ETD approval by the Graduate School and completion of all other requirements for the degree.

Commencement Participation

Master's students who have completed their degree requirements, and those nearing completion, can participate in Commencement. However, diplomas are not issued until all degree requirements are met. Summer graduates may attend either fall or spring commencement but must confirm their attendance through Hokie SPA. Doctoral candidates, to be eligible to participate in the doctoral hooding ceremony, must have completed all degree requirements including ETD approval by the Graduate School by the deadlines published each semester on the Graduate School website:

http://graduateschool.vt.edu/academics/commencement_deadlines

Academic Regalia

Information on master's and doctor's regalia is available from the University Bookstore, Clothing and Gifts department, 540/231-5991 <http://www.bookstore.vt.edu>

Degree Conferring Dates

In addition to the traditional twice-a-year commencement, two additional "Degree-Conferring Dates" have been established. These dates appear on the diploma for qualified graduates. These additional degree-conferring dates fall on the last day of final examinations of First Summer Term and Second Summer Term. No commencement ceremonies are conducted during the summer. Students who complete degree requirements during summer may attend the next commencement; students must confirm commencement attendance via Hokie SPA. All degrees conferred between commencements are listed in the next commencement program. Diplomas will be mailed to graduates by first class mail.

Appeals

Graduate Student Appeals

[See additional information in Expectations for Graduate Education: Complaints and Appeals, <http://graduateschool.vt.edu/node/6060>] Graduate education is a complex activity involving a high order of student-faculty relationship. It follows that the evaluation of the graduate student's progress is, and must be, dependent in large part on the

judgment of the student's Advisor and augmented by the collective judgment of the members of the Advisory Committee. The university, through the Graduate School, defines minimal entrance standards and general rules governing eligibility for continuation in graduate programs. However, the crucial agency in student evaluation is the student's Advisor and other Advisory Committee members. It is important that each graduate student be fully informed, not only of the Graduate School Policies and Procedures, but of any additional departmental program requirements beyond those of the Graduate School. The Graduate School website provides a link to departmental policy requirements at http://graduateschool.vt.edu/graduate_catalog/programs.htm. The department should inform graduate students of their degree requirements at the time of matriculation. It is assumed that most problems involving graduate education will be discussed informally and reconciled at the departmental level. Indeed, most discussions of this kind will commonly occur among the student, the Chair of the student's Advisory Committee, and the other members of the Advisory Committee. However, from time to time serious questions may arise that place the student's status in jeopardy. On these occasions it is important that the university provide full opportunity for the student's grievance to be reviewed in a judicious manner.

The Departmental Appeal

When a graduate student believes that any work has been improperly evaluated, or believes that there has been unfair treatment, it is expected that the student will take up the questions directly with the faculty member involved. This may be the student's Advisor, other faculty members, or an instructor responsible for a course. If, after earnest inquiry, the matter remains unreconciled, the graduate student will be expected to appeal the question to the Department Head (the Graduate Program Director also may be involved in this level of appeal). If the Department Head is a party to the grievance, the Dean of the academic college will assume this responsibility. The Department Head, in consultation with the college Dean, shall take all reasonable and proper actions to resolve the question at the departmental level. The student shall be informed in writing of the results no later than one month after the appeal to the Department Head. In some matters, the Faculty Handbook provides additional relevant information, for example, "the assigning of grades is the responsibility of the individual instructor in every case. The basis on which grades are assigned rests on his/her judgment alone....").

The University Appeals Procedure

Should the aggrieved student believe that the student's rights were abridged at the departmental level, the student may file an appeal with the Dean of the Graduate School. In a statement to the Dean, the aggrieved student must clearly state the substance of the appeal. The Dean of the Graduate School shall take all reasonable and proper actions to resolve the question or refer it directly to the Graduate Appeals Committee for its review. As a standing committee of the Commission on Graduate Studies and Policies, this committee will consist of three faculty members and one graduate student. For each appeal the dean shall appoint to the committee one additional faculty member knowledgeable in the academic area of the appeal. The review by the Graduate Appeals Committee will have available to it all pertinent information in the student's record in the university and (a) the department's policy statement concerning its degree expectations, (b) a summary of the department's action on the appeal, and (c) copies of the student's statement to the Dean of the Graduate School recording the student's view of alleged irregularities (i.e., the basis for university appeal). The Graduate Appeals Committee may hold a formal hearing on grievance appeals referred to it by the Dean of the Graduate School.

The hearing will be conducted with the following procedural safeguards:1. All parties to the dispute will be notified of the time and place of the hearing at least 48 hours in advance;2. The aggrieved student will be permitted, if the student chooses, to invite a member of the faculty or student body to represent him/her in the hearing;3. All parties in the dispute will be given full opportunity to testify and to present such evidence or witnesses as seem relevant;4. All matters on which the finding will be based must be introduced into evidence at the hearing. The Graduate Student Appeals Committee will make a recommendation to the Dean of the Graduate School, which will be acted upon by the Dean of the Graduate School in consultation with the Provost. The Dean will convey the committee's recommendation and the final disposition of the matter to all concerned parties.

BIOMEDICAL AND VETERINARY SCIENCES

Professors: S Ahmed; Virginia Buechner-Maxwell; Gregory Daniel; Marion Ehrlich; Francois Elvinger; David Hodgson; Thomas Inzana; Karen Inzana; Martha Larson; Michael Leib; David Lindsay; Xiang-Jin Meng; David Panciera; James Pickett; William Pierson; Nammalwar Sriranganathan; William Swecker; William Whittier; Jeffrey Wilcke;

Associate Professors: Jonathan Abbott; Michele Borgarelli; Sherrie Clark-Deener; Linda Dahlgren; Piedad Henao Guerrero; Ian Herring; William Huckle; Bradley Klein; Kevin Lahmers; Otto Lanz; Nadarajah Nanthakumar; Bess Pierce; John Rossmesl; William Scarratt; Elankumaran Subbiah; Sharon Witonsky; Anne Zajac;

Assistant Professors: Irving Allen; Jennifer Barrett; Katie Boes; Clayton Caswell; Thomas Cecere; Nikolaos Dervisis; David Grant; Jia-Qiang He; Sandra James-Yi; Tanya LeRoith; Xin Luo; Carolina Ricco Pereira; Michelle Theus; Lijuan Yuan; Kurt Zimmerman;

Research Faculty: Willard Eyestone; Theresa Hrubec; Christopher Reilly;

Graduate Contact: bjones57@vt.edu

Biomedical & Veterinary Sciences: <http://www.vetmed.vt.edu/acad/grad/>

The Department of Biomedical and Veterinary Sciences (BMVS) is an integral part of the College of Veterinary Medicine and the Graduate School of Virginia Tech. The graduate program was initiated in 1986. In contrast to many departments and colleges on this campus, there is a single multidisciplinary graduate program for our college which is recognized by the Graduate School as a graduate department. The goal of our program is to provide the students with a sound background in the basic and clinical sciences and to cultivate the ability to apply rigorous scientific thinking to advanced biomedical and veterinary sciences. A basic philosophy of graduate education in biomedical and veterinary sciences is flexibility. Programs of study - courses, laboratory and field research, clinical experiences, and teaching opportunities - are tailored to meet the individual student's needs, depending on academic background, professional experience and career goals. The college prides itself on the high quality of faculty mentoring/advising, and support services.

SPECIAL FACILITIES

Faculty Research Laboratories are will equipped for modern molecular research and/or clinical studies. The following Core Research Service Laboratories are available to support the work of graduate students.

Center for Molecular Medicine and Infectious Diseases (CMMID)

Flow Cytometry

Glassware/Media Preparation

Morphology

Physiology and Clinical Research

Quality Assurance Unit

Study Design and Statistics

Toxicology

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (570.0)

Computer: (230.0)

iBT: (90.0)

GRE

Verbal and Quantitative : Combined Score (1070.0), New GRE Test Scale Combined Score (300.0)

The MS degree comprises a combined total of 30 credit hours of course work, research and thesis, and can be completed in two years.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (570.0)

Computer: (230.0)

iBT: (90.0)

GRE

Verbal and Quantitative : Combined Score (1070.0), New GRE Test Scale Combined Scores (300.0)

The PhD degree comprises a combined total of 90 credit hours of course work, research and dissertation. The PhD can be completed in four years. It is not required to have a Master's degree before entering the

PhD program.

GRADUATE COURSES (BMVS)

BMVS 5005 (VM 9085):

Emerging Infectious Diseases

Stand-alone, fully on-line, asynchronous distance and distributed learning course, accessible as streaming videos on the internet or on CDs. 5005: The course defines and discriminates amongst numerous factors influencing the emergence of infectious diseases. Selected emerging food-borne, bacterial, viral, zoonotic diseases of animals and humans are described and analyzed. 5006: The course expands the pathology of emerging infectious diseases. Additional viral, parasitic and zoonotic diseases of animals and humans are described and analyzed. Xenotransplantation is also discussed from the perspective of zoonotic diseases. Third year standing in the DVM curriculum, or good standing in a graduate studies program is required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5006:

Emerging Infectious Diseases

Stand-alone, fully on-line, asynchronous distance and distributed learning courses, accessible as streaming videos on the internet or on CDs. 5005: The course defines and discriminates amongst numerous factors influencing the emergence of infectious diseases. Selected emerging food-borne, bacterial, viral, zoonotic diseases of animals and humans are described and analyzed. 5006: The course expands the pathology of emerging infectious diseases. Additional viral, parasitic and zoonotic diseases of animals and humans are described and analyzed. Xenotransplantation is also discussed from the perspective of zoonotic diseases. Third year standing in the DVM curriculum, good standing in a graduate studies program is required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5014:

Animal Pathology Residency

Training in diagnostic pathology through weekly rotations in the necropsy and surgical biopsy service of the teaching hospital. Students will perform necropsies and histopathologic examinations of necropsies and surgical biopsies and write diagnostic reports. The course is taken in weekly intervals of necropsy and/or surgical biopsy, with a credit hour given for each 2-week interval. Variable credit. May be repeated with a maximum of 5 hours. DVM degree required.

Credit Hour(s): 1 TO 5

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s):

Corequisite(s):

BMVS 5034G:

Advanced Environmental Health Toxicology

Health effects associated with the exposure to chemicals, identifying and managing problems of chemical exposure in the work place and the environment, fundamental principles of toxicodynamics and toxicokinetics, and risk assessment. Emphasis on conceptual understanding of chemical entry into the body, biotransformation, and elimination from the body. Identification of factors influencing environmental toxicoses and the overall risk to human health and ecological welfare from multiple classes of environmental toxicants. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5044 (VM 8064):

Veterinary Immunology

Study of immunological mechanisms effective in protecting animals from infectious and foreign agents. Includes the use of immunological reactions for diagnostic purposes and the role of immune mechanisms in the induction of diseases. I

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5054 (VM 8124):

Study of general virology, e.g. classification, physico-chemical characteristics, replication, recognition of and immune response to members of different viruses families. Study of clinical signs, pathology, histopathology, prevention and diagnosis of animal virus diseases by species of animals. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMVS 5044 (UG) OR BMVS 5044

Corequisite(s):

BMVS 5084:

Macromolecular Interfaces with Life Sciences Seminar

Experience in developing and presenting a technical seminar related to oxidative processes at the macromolecule- biomolecule interface. Tours and presentations at research facilities at regional industrial sites. Idea generation for the purpose of resolving technical questions and advancing research projects. Pre: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell and molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5094 (CHEM 5094):

Grant Writing and Ethics

A framework for writing clear, concise grant proposals in a team-oriented, multidisciplinary approach from concept development through submission to a funding agency. Potential ethical dilemmas that may arise in academic, industrial, or federal research settings will be discussed. PRE: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell and molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. (3H, 3C) Graduate standing required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5124 (VM 8474):

Reproductive Pathology

Study of lesions of the reproductive system of domesticated animals.

Relationship of these lesions to infertility and examination of the pathogenesis of the lesions and infertility. I

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ALS 4304 (UG) OR ALS 4304

Corequisite(s):

BMVS 5144:

Oncology Pathology

This course presents the pathology of neoplasms of all organ systems by using assigned reading, tutorials, tissue sections and discussion.

Emphasis is on the clinical presentation, histologic diagnosis, and prognosis of each neoplasm. Formal lectures are not given. Independent study and twice weekly discussion sessions. DVM degree required. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): VMS 5134 (UG) OR VMS 5134

Corequisite(s):

BMVS 5154G:

Advanced Lab Animal Management

Advanced 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 research 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, this course is designed to complement graduate studies in biological, biomedical, and life sciences which involved the use of animals in research. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5174:

Scientific Integrity

Issues relating to scientific integrity and the responsible conduct of study as related to research in the biological, veterinary, animal and natural

sciences. The topics covered include methods, ethics and the scientist, mentoring, authorship and peer review, use of humans and animals in experimentation, managing conflicting interests, collaborative research, ownership of data and intellectual property, genetic technology, scientific record keeping. Pre-requisite: Completion of one year of graduate coursework

Credit Hour(s): 2

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5184G:

Advanced Medical Toxicology

Adverse health effects of exposure to drugs or substances of abuse. Covers principles of toxicodynamics, toxicokinetics, biotransformation, diagnosis and treatment. Emphasis will be placed on mechanism(s) of action of the various drug classes, body system(s) affected, clinical manifestations of problems and the resulting adverse affects on human health and society. Methods of treatment and client education will also be addressed. Laws controlling and governing the use of these drugs/substances and the agencies responsible for them will also be covered. Cross-listed with VM 9204. Graduate standing required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5194:

Clinical Micropathology

This course presents practical topics in diagnostic pathology. It covers the entire spectrum of disease processes, including the background of clinical, gross anatomic physiologic information required for integration with the microscopic changes observed to arrive at a correct diagnosis. DVM degree and permission of the instructor required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5204:

Advanced Veterinary Cytology

Advanced course in veterinary cytologic interpretation. Selected cytologic specimens of normal and diseased tissues are examined microscopically, described and interpreted. Course may be taken more than once. (Maximum 4 credits). DVM degree and permission of instructor required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5214:

Pharmacology and Toxicology Testing

Procedures and methods used to approve new drugs and chemicals for marketing. Experimental design, practical considerations, legal requirements, evaluation of general and specific toxicology testing methods, risk assessment, and prospects for changes in current testing methods will be covered. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 4204 (UG) OR BCHM 4204

Corequisite(s):

BMVS 5224 (BMES 5024):

Biomedical Engineering and Human Disease

Comprehensive overview of a variety of human diseases, including neurological disorders, cardiovascular disease, infectious disease, and cancer, designed primarily for graduate students majoring in engineering and other related areas who have a long-term academic and professional goal in the field of biomedical engineering and life sciences. Introduction to state-of-the-art biomedical engineering approaches used for the study of early detection/diagnosis, treatment and prevention of human disease. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMES 5004 OR (BMVS 4064 (UG) OR BMVS 4064)

Corequisite(s):

BMVS 5244 (VM 8314):

Veterinary Pharmacology

Principles of pharmacodynamics and pharmacokinetics, including interaction of drugs with receptors; absorption, distribution and

clearance; drug metabolism and drug interactions. Study of drugs by pharmacological classes, the general mechanisms of action, usefulness and side effects. Pharmaceutical calculations and prescription writing. May be repeated for a maximum of 5 credits. Pre-requisite: Graduate standing required

Credit Hour(s): 1 TO 5

Lecture Hour(s): 1 TO 5

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5254 (VM 8424):

Veterinary Toxicology

Study of toxic agents, mechanisms and action, toxicoses, and treatments, especially as related to domestic and wild animals.

Principles of toxicity testing and clinical diagnosis. Second-year standing in the DVM curriculum is required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ALS 5304 (UG) OR ALS 5304

Corequisite(s):

BMVS 5274:

Systems Pathology

This lecture only course covers the pathology and pathogenesis of specific lesions and diseases of each organ system at the gross and microscopic level. Emphasis is on diagnostic characteristics and interpretation of diseases. Pre: DVM or equivalent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5284:

Cellular Pathology

This course presents the mechanisms involved in cellular reaction to injury, inflammation, tissue repair and regeneration, circulatory disturbances (thrombosis, embolism, infarction, hemorrhage, edema, congestion, shock) and neoplasia and other alterations of cell growth. Emphasis will be placed upon disease processes at the cellular and tissue levels.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5305 (VM 8124):

Veterinary Oncology

These companion courses are designed to provide intensive study of the biology of neoplasms, their diagnosis, clinical presentation and treatment. 5305: Introductory/review lectures: factors in protooncogene mutation, methods of diagnosis, and cancer epidemiology. A second portion of this course discusses important neoplasms of various animal species and body systems, and classical methods of treatment. 5306: In-depth discussion of cancer chemotherapy, immunotherapy, and new advances in therapy such as gene replacement/modification. Pre: third-year standing in the DVM curriculum.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5306:

Veterinary Oncology

These companion courses are designed to provide intensive study of the biology of neoplasms, their diagnosis, clinical presentation and treatment. 5305: Introductory/review lectures: factors in protooncogene mutation, methods of diagnosis, and cancer epidemiology. A second portion of this course discusses important neoplasms of various animal species and body systems, and classical methods of treatment. 5306: In-depth discussion of cancer chemotherapy, immunotherapy and new advances in therapy such as gene replacement/modification. Pre: third-year standing in DVM curriculum.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5314:

Membrane Physiology

General topics of membrane physiology. Emphasis on mechanisms involved in the transduction of extracellular signals into physiological changes within the cell. Specific topics include: receptor-agonist

interactions, phos-phatidylinositol turnover, changes in the concentrations of intracellular free calcium and/or cyclic AMP, protein kinase C, and prostaglandins.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5324:

General Neurochemistry

Biochemical mechanisms involved in normal and abnormal nervous system function including discussions of experimental techniques, structural components, neurotransmitters, cerebral blood flow and metabolism, sensory systems, learning, mental disorders, and neuropharmacological agents.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BCHM 4116 (UG) OR BCHM 5124 (UG)) OR (BCHM 4116 OR BCHM 5124)

Corequisite(s):

BMVS 5364:

Ultrastructure Methodology in Biological Sciences

An introduction to the methodology of transmission electron microscopy as it applies to the life sciences. The goal of the course is to provide students who expect to use ultrastructure as a research tool with the fundamental principles behind the techniques, and hands-on experience in preparing and examining them in the electron microscope. Students prepare tissues and will generate a final project in the form of a journal article. Because of the intensive nature of the laboratory portion, course enrollment is limited to 15 students, and permission of the instructor is required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): BIOL 4504 (UG) OR BIOL 4504

Corequisite(s):

BMVS 5384:

Oxidation at the Interface of Chemistry and Biology

An advanced survey of the chemistry and biochemistry associated with oxidation reactions and the relationship to positive and detrimental

outcomes in synthetic and natural macromolecules and biological systems. Topics include free radical chemistry, reactive oxygen and nitrogen species in living systems, enzyme-catalyzed oxidations, oxidation of foods and materials, oxidative stress and health effects, chemistry of antioxidants. Pre: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell & molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5414:

Reproductive Cell Biology

Detailed study of the processes of gamete production, gamete maturation, fertilization, and early embryo pre-implantation development, by analysis of the known molecular changes which gametes and embryos undergo. Emphasis will be on oocyte maturation, sperm capacitation, and embryo development through blastocyst. Extensive use of current literature.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ALS 5314 (UG), BCHM 5124 (UG)) OR (ALS 5314, BCHM 5124)

Corequisite(s):

BMVS 5434 (VM 8014):

Veterinary Anatomy I

Study of the basic structural and functional anatomy of carnivore (dog, cat), horse, and ruminants. Gross morphology is applied to clinical diagnosis, interpretation, surgical and medical treatment. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5444 (VM 8264):

Veterinary Anatomy II

Study of the structural and functional anatomy of carnivores (dog, cat), horses, and ruminants. Gross, developmental and radiographic morphology with applications for clinical diagnosis, interpretation, and

surgical and medical treatment. II

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): VM 8014 OR BMVS 5434 (UG) OR BMVS 5434

Corequisite(s):

BMVS 5454 (VM 8034):

Veterinary Physiology I

Study of physiological functions in companion, food, fiber, laboratory, zoo, and wildlife animal species. Emphasizes fundamentals and the overview of cellular, organ, and regulatory integration. Topics include cells, muscles, blood, respiration, circulation, environmental and regulatory physiology. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5464 (VM 8134):

Veterinary Physiology II

Study of how living animals function. The central themes include close relationship between structure and function, process of adaptation, and the concepts of homeostasis and feedback control systems. The course focuses on the function of the tissues, organs, and organ systems of multicellular organisms. II

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5474 (VM 8384):

Veterinary Neurobiology

Normal structure and function of the mammalian nervous system. Basic neuroanatomy, neurophysiology, neurochemistry, and neurohistology of sensory, motor, integrative, and regulatory systems will be discussed, as well as metabolic support systems. II

Credit Hour(s): 0 OR 2

Lecture Hour(s): 0 OR 4

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5514:

Musculo-skeletal Surgical Advanced

Myology, arthrology, osteology and biomaterials will be reviewed to provide state of the art information to graduate veterinarians. Research directions and trends will be stressed. Laboratory experience with selected problems. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5524:

Veterinary Clinical Nutrition Consultation

The Veterinary Clinical Nutrition Consultation course provides graduate students with clinical experience in clinical nutrition of small and large animal species. Students will be assigned clinical consults in nutrition from cases presented to the small and large animal hospital and from field services (AHS and PMM) at the VMTH. The student will be responsible for documenting the consult for the medical records. The student will participate in clinical rounds in the different service areas at the VMTH on a rotational basis. Repeatable with maximum of 6 credits. DVM degree required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5534:

Topics in Advanced Small Animal Gastroenterology

In-depth study of small animal gastrointestinal medicine. The student will be exposed to both common and uncommon disorders of the gastrointestinal system. Gastrointestinal controversies will be explored. DVM degree required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Molecular Aspects of Nutrition and Disease

The role of specific nutrients in human and animal health at a physiologic and molecular level. Emphasis is placed on the influence of nutrients on gene expression especially with regard to pathophysiology of diseases.

Physiological and molecular aspects of nutrition and immune function will also be discussed. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5124 (UG), (ALS 5104 (UG) OR HNFE 5104 (UG)) OR BCHM 5124, (ALS 5104 OR HNFE 5104)

Corequisite(s):

BMVS 5554:

Advanced Surgery of the Special Senses and Skin

Conceptual and practical development of surgical principles and progress that have occurred in recent years within these fields.

Neurology, ophthalmology, audiology, and dermatology will be considered from a surgical perspective. Current problems and research areas will be reviewed. Laboratory manipulations are used to increase skill levels in these areas. DVM degree required. III

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5564 (VM 8534):

Introduction to Clinical Research

Design of studies in veterinary related clinical research, planning and implementation of experimental and survey data collection, management and analysis of data, evaluation of analysis and critical evaluation of published information. Instructor approval required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5574:

Advanced Poultry Diseases

An advanced course covering diagnosis, etiology, and treatment of poultry diseases. Diseases will be grouped by system affected, their common features detailed, and then unique characteristics of these

diseases described. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5604:

Principles and Methods in Equine Surgery

Graduate level course in advanced techniques in equine surgery.

Activities include elucidation of pathophysiology, diagnosis, and surgical approach to complex equine conditions including nonroutine cases as they are presented. DVM degree required. Maximum 3 credits.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5614:

Principles and Methods in Equine Internal Medicine

Graduate level course in the application of advanced techniques in equine internal medicine. Activities will include elucidation of pathophysiology, performance of diagnostic methodology, and therapeutic management of complex medical disorders affecting the equine species. Course will be offered at the Marion duPont Scott Equine Medical Center. DVM Degree required. I,II,III

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5624:

Molecular Virology

The principles and mechanisms of virus replication at the molecular level including transcription, translation and posttranslational modifications of virus genes, virus interaction with host, antivirals, vaccines and host defense mechanisms against virus infections. The replication and pathogenesis mechanisms of several important DNA and RNA virus families including biothreat viruses. Graduate standing required.

Credit Hour(s): 2

Lecture Hour(s): 2

25 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5654 (VM 8454):

Veterinary Clinical Nutrition

This course considers the nutritional needs of species of veterinary importance throughout life and for various work-loads and purposes.

Nutritional management of diseased or compromised patients is considered. Pre: second-year standing in the DVM curriculum or completion/test-out of VM 8234 or equivalent course.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5664:

Path Animal Models Disease

Experimental pathology and laboratory animal research. Focus on the mouse models; other models included where applicable. Pre-requisite:

Third year standing in the DVM curriculum.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5704 (VM 8704):

Veterinary Cytopathology

Interpretation of cytopathologic samples. Descriptive reports. Routine to complex case material from animal tissue specimens. Pre-requisite:

Third year standing in the DVM curriculum.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5714:

Biomedical Literature

This course deals with searching the literature in Biomedicine, both in printed form as well as computerized bibliographic databases. It also covers the topic of managing personal collection of published materials

for effective retrieval. This course is for graduate students enrolled in biomedical research programs.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5734 (VM 8414):

Clinical Pathology

The study of relating abnormal clinical laboratory data to specific organ dysfunctions or lesions with emphasis on data interpretation and on understanding the pathophysiologic mechanisms leading to abnormal data. Additional emphasis will be placed on understanding the diagnostic and prognostic value of thoughtfully selecting pertinent laboratory tests to aid in the medical management of clinical cases. Alterations in the hematology, clinical chemistry, urinalysis, and cytology of the major domestic species will be studied. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5744 (VM 8324):

Veterinary Parasitology

Study of the morphology and biology of parasites of veterinary importance. Considers of pathogenesis, diagnosis, signs, and treatment of parasitic diseases of animals. Study of the immunologic and pathophysiologic aspects of host/parasite relationships and the importance of zoonotic parasitic infections. II.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5754 (VM 8334):

Veterinary Bacteriology and Mycology

Study of important bacterial and mycotic agents that cause disease of economic and public health significance in food and fiber, companion, laboratory and zoo/wildlife animal species. Special emphasis is on: habitat, microbial characteristics, virulence attributes, pathogenesis, immunity, approaches to prevention, antimicrobial susceptibility and

diagnosis. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5764 (VM 8494):

Aquatic Medicine and Fish Health

The etiology, diagnosis, pathology, pathogenesis, chemotherapy, control and management of infectious and non-infectious diseases of aquatic organisms, especially pertaining to cultured food and tropical fish. Hands on experience with water quality evaluation, diagnostic techniques and the identification of common pathogenic organisms. Pre-requisite:

Second year standing in the DVM curriculum.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): VM 8364 OR FIW 4514 (UG) OR FIW 4514

Corequisite(s):

BMVS 5794:

Clinical Neuropathology

This course uses necropsy tissues of clinical cases to present the mechanisms involved in neurologic disease of animals. Gross, microscopic, and radiologic approaches will be employed. Emphasis will be placed upon the correlation of clinical and pathological findings. May be repeated. Pre: Instructor's approval required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5814 (VM 8254):

Functional Morphology and Natural History of Reptiles and Birds

Anatomical features will be described that are unique to, or are characteristic of, each major group covered. Adaptation and successful exploitation of habitat. Use of anatomical features and functions.

Selected attributes of the group's natural history, members of the group common to the local and extended area, those commonly kept as pets.

Pre-requisite: Graduate Standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5824 (VM 8264):

Small Animal Nutrition

Practical feeding guidelines for companion animals. Special consideration also given to the relationship of diet to nutrient excesses and deficiencies that result in clinical disorders. Diagnosis, treatment, and prevention of metabolic disorders of companion animals will be discussed.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5834 (VM 8384):

Food Animal Nutrition

Practical feeding guidelines for food animals. Special consideration also given to the relationship of diet to nutrient excesses and deficiencies that result in clinical disorders. Diagnosis, treatment, and prevention of metabolic disorders of food animals will be discussed.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): VM 8454

Corequisite(s):

BMVS 5844 (VM 8394):

Equine Nutrition

The course is designed to provide practical feeding guidelines for different classes of horses. The relationship between nutrition and clinical disorders of the horse is explored including their nutritional management. Students will be expected to complete a problem-solving nutrition project during the course.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): VM 8454

Corequisite(s):

Veterinary Cardiorespiratory System

This course concentrates on respiratory and cardiovascular diseases of the common domestic species. Emphasis is given on teaching students how to develop a data base for these two body systems using effective communications and modern diagnostic tools. The course focuses on the common diseases of these systems and how these diseases are managed and treated. Pre: second-year standing in the DVM curriculum.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5874:

Food Animal Theriogenology

Presents the practice of food animal theriogenology for individuals interested in working within food animal production systems. The course will include reproductive management for herds of food animal species including cattle, sheep, goats and swine. Emphasis is on clinical aspects of reproductive diseases and management. Consists of lectures, laboratories and discussion groups. Pre: VM 8374 or equivalent.

Graduate standing required.

Credit Hour(s): 0 OR 2

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): VM 8374

Corequisite(s):

BMVS 5884:

Macromolecular Chemistry at the Biology Interface Laboratory

An advanced laboratory course that involves state-of-the-art experimental techniques with applications for data interpretation and presentation for future professionals at the polymer chemistry-biology interface. Team-oriented experiments will use traditional and emerging polymer chemistry techniques and applied biological methods, specifically those involving analysis of free radical and oxidative processes. PRE: CHEM/FST/BMVS 5384 or simultaneous enrollment in this course.

Credit Hour(s): 0 OR 2

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5944:

Seminar in Biomedical and Veterinary Sciences

Presentations by graduate students on current topics in Biomedical and Veterinary Sciences. Topics and responsibility for seminars is rotated among the professional departments of the college. Maximum 4 credits.

I,II,III

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BMVS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

28 Prerequisite(s):

Corequisite(s):

BMVS 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BMVS 6014:

Veterinary Clinical Sciences Residency

Advanced course with training and instruction in veterinary patient management. Supervised practicum in veterinary diagnosis and therapy in a veterinary teaching hospital. Material will include development of knowledge and skills for problem solving, performance of techniques, and effective communication. Regularly scheduled rounds and conferences will supplement daily activities. 0 credit. DVM degree required.

Credit Hour(s): 0

Lecture Hour(s): 0

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6064:

Advanced Topics in Veterinary Medicine

Students will critically review and actively participate in discussion of current and important historic veterinary and comparative medical literature relevant to student's residency specialty. DVM degree is required. May be repeated with different content for a maximum of 12 credit hours.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6074:

Clinical Topic Rounds

Practical, advanced training in specialty medicine. Students will participate in critical reviews of cases and current literature applicable to selected cases. Relevant information will include advanced diagnostic and therapeutic techniques applicable to the specialty and species being

studied. An in-dept knowledge of the pathophysiology of animal disease processes and clinical problem solving will be developed. Students will be expected to gain an understanding of the general problem area to be studied and critically evaluated current literature and application to the case(s) being studied. DVM degree is required. May be repeated with different content for a maximum of 12 credit hours.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6084:

Veterinary Speciality Clinics

Practical, advanced training in specialty medicine. Students will learn advanced diagnostic and therapeutic techniques applicable to the specialty and species being studied. An in-depth knowledge of the pathophysiology of animal disease processes and clinical problem solving will be developed. Students will be given responsibility for case management with faculty guidance. DVM degree is required. May be repeated for a maximum of 12 credits with different content.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6094:

Board Certification Topics

Structured preparation for the specialty examinations associated with residency programs and board certification. Topics will vary depending on the particular learning objectives required by the clinical discipline. Pre-requisite: Graduate standing and clinical resident in the Virginia Maryland Regional College of Veterinary Medicine. May be repeated for up to 6 credit hours with different content.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6114:

Topics in Pathogenic Bacteriology

Journal articles on the molecular basis of bacterial pathogenesis

published in the past year will be reviewed and discussed. While the emphasis will be on bacterial factors responsible for disease or virulence, papers on host factors responsive to bacterial infection may also be reviewed. Papers will be assigned by the instructors and chosen by the students. The topics will vary and the course may be taken for credit no more than 3 times. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BIOL 2604 (UG) OR VMS 8334), BIOL 4624 (UG), (BIOL 4704 (UG) OR VMS 8064), BIOL 4674 (UG)

Corequisite(s):

BMVS 6514 (VM 8514):

Equine Theriogenology I

An advanced study in the breeding management, estrous cycle manipulation, embryo transfer, parturition and the foaling issues, reproductive disease diagnoses and treatment of the mare and stallion. Practical application of the latest research covered in this species. Pre:

Second-year standing in the DVM curriculum. II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): VM 8634 OR (ALS 4304 (UG) OR ALS 4304)

Corequisite(s):

BMVS 6534:

Mechanisms of Disease in Veterinary Medicine

Advanced study of topics concerning the pathophysiology, diagnosis, and current therapy of diseases in Veterinary Medicine. Pre: DVM or equivalent, or consent of instructor. May be repeated to a maximum of 18 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6554 (VM 8684):

Advanced Epidemiology

This course is intended for students interested in applying analytical epidemiological methods in assessing the health and disease status of populations (animal and/or human) and the factors affecting that status. It will include lecture/discussion sessions and exercises on the design,

analysis, and interpretation of clinical trials and cross-sectional, case-control, and longitudinal studies. Risk assessment and techniques for assessing and enhancing the validity of epidemiological studies will also be covered. Pre: third-year standing in the DVM curriculum.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6564 (VM 9094):

Advanced Veterinary Public Health

Consideration of the organization and delivery of Veterinary Public Services at the local, state, national and international levels including zoonoses surveillance, investigation and response to disease outbreaks, biological warfare and terrorism, response to natural emergencies and disasters, and public health policy formulation. Pre: third-year standing in the DVM curriculum.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6574 (VM 9214):

Animals and Public Policy

Course will examine society's changing attitudes toward the care and use of animals and examine the philosophical spectrum between animal welfare and animal rights. Will explain the role of the major regulatory and accrediting organizations in setting standards of care for animals used in research, exhibition, transportation, and production. Will describe the regulatory process for making policies and regulations to support federal legislation. Will provide information on the currently acceptable standards for the care and use of animals for regulated purposes. Pre: third-year standing in the DVM curriculum.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6584 (VM 9234):

Veterinary Public Policy

30 Overview of the formulation and implementation of public policy at the

local, state, and national level through legislation, regulation, and operational strategy. Understanding of the concepts of legal authority and public mandate. Training in risk communication and media relations. Review of current public policy issues related to veterinary medicine, animal and human health such as food safety, animal disease control, animal welfare, business practices. National leaders will interact with the class to discuss current issues. Pre: third-year standing in the DVM curriculum.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6594 (VM 9244):

International Veterinary Medicine

Overview of international veterinary activities. Understanding of the role of governmental agencies, inter-governmental and non-governmental organizations in international relations, development, relief work, conservation, disease control and prevention, and trade. Understanding of the legal authority of binational agreements and international treaties. Training in intercultural communications, negotiation and conflict resolution. Review of current global issues. Pre: third-year standing in the DVM curriculum.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6704:

Topics in Immunology

Readings and discussion in a specific area of immunology. Topic will vary and course may be taken for credit more than once. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMVS 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ACCOUNTING AND INFORMATION SYSTEMS

Reza Barkhi, Head

Professors: Reza Barkhi; France Belanger; Robert Brown; C Cloyd; Weiguo Fan; James Jenkins; John Maher; Wilmer Seago;

Associate Professors: Sudip Bhattacharjee; John Brozovsky; Debra Salbador; Steven Sheetz; David Tegarden; Linda Wallace;

Assistant Professors: Brooke Beyer; Thomas Hansen; Jingjing Huang; Eugene Johnson; Mitchell Oler; Velina Popova; Sarah Stein; Michael Wolfe;

R. B. Pamplin Professor: France Belanger; Wilmer Seago;

Curling Professor: Robert Brown;

John E. Peterson, Jr. Professor: C Cloyd;

John F. Carroll, Jr. Professor: John Maher;

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Graduate Site: <http://graduateschool.vt.edu>

Department Site: <http://www.acis.pamplin.vt.edu>

The accounting and information systems department offers programs of graduate study leading to degrees of master of accounting and information systems and Ph.D. in business with a major in accounting and information systems.

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (650.0)

Computer: (280.0)

iBT: (115.0)

GMAT

: Total (640.0)

Ph.D. Program Requirements: Minimum GPA: 3.2; Minimum TOEFL: 650/280/115; Minimum GMAT Score: 640 The program leading to the Ph.D. in business with a major in accounting and information systems permits the student to pursue advanced graduate studies in preparation for a career in college and university teaching and research. The first two or three years of the Ph.D. program are devoted to course work. The program's basic requirements include core course work in accounting and information systems and research methods, as well as course work in a supporting area and statistics. The remainder of the time is devoted to the dissertation. There is no foreign language requirement, although computer proficiency is expected. The supporting area can be chosen from among the field options within the Pamplin College of Business or in an area outside the college, subject to approval by the student's advisory committee. The following specific courses are required in the major field: ACIS 5974, 6004, and two of the following: 6014, 6024, and 6504. Depending on a student's background, additional ACIS courses may be required. Each candidate for the Ph.D. in business with a major in accounting and information systems must pass the written examination at or near the completion of course work, defend a dissertation proposal before the accounting and information systems faculty, and pass a final oral examination after the dissertation is completed.

MACIS Degree

Offered In (Blacksburg)

TOEFL

IBT: (105.0), (0.0)

Computer: (260.0)

iBT: (105.0)

GMAT

: Total (520.0)

Master of Accounting and Information Systems Program The master of accounting and information systems program provides graduate-level education for professional careers in accounting and information systems. For those planning to enter a Ph.D. program, the program offers the necessary foundation. The program is open to students with a bachelor's degree in any discipline. Students without prior collegiate studies in accounting, information systems, and/or business administration can expect to spend additional time in the program completing prerequisites. For those who have fulfilled the background requirements, the program consists of 30 semester hours and can normally be completed in 12 to 17 months. No more than one grade of C and no grades less than C may be earned by candidates for graduate degrees (this excludes undergraduate prerequisites). A second grade of C, or any grade less than C, will result in automatic expulsion from the program, absent extenuating circumstances approved by the student's course advisor and the department head. All masters of accounting and information systems students take the following two courses: ACIS 5214 Advanced Strategic Cost Management ACIS 5514 Management of Information Systems The additional eight courses depend on the student's choice of one of four possible career options: Audit, Tax, Financial Services, or Information Systems. Additional courses for these

options are as follows: Audit: ACIS 4534 Accounting Information Systems Arch. ACIS 5014 Information Systems Audit and Control ACIS 5324 Taxation of Business Entities ACIS 5414 Auditing Theory ACIS 5584 Information Systems Security and Assurance FIN 5194 Commercial Law Plus two of the following six courses: ACIS 5024 Ethical Issues in Accounting ACIS 5034 Global Issues in Accounting and Information Systems ACIS 5124 Governmental and Nonprofit Accounting ACIS 5134 Mergers and Acquisitions ACIS 5194 Financial Statement Analysis ACIS 5444 Forensic & Investigative Accounting Tax: ACIS 5314 Tax Concepts and Research ACIS 5324 Taxation of Business Entities ACIS 5334 Advanced Corporate Tax ACIS 5364 Multi-jurisdictional Tax Concepts ACIS 5414 Auditing Theory FIN 5194 Commercial Law ACIS 5024 Ethical Issues in Accounting OR ACIS 5034 Global Issues in Accounting and Information Systems OR ACIS 5444 Forensic & Investigative Accounting ACIS 5124 Governmental and Nonprofit Accounting OR ACIS 5134 Mergers and Acquisitions Financial Services: ACIS 5194 Financial Statement Analysis ACIS 5324 Taxation of Business Entities ACIS 5414 Auditing Theory FIN 5124 Investment Analysis/Portfolio Management FIN 5194 Commercial Law ACIS 5024 Ethical Issues in Accounting OR ACIS 5034 Global Issues in Accounting and Information Systems OR ACIS 5444 Forensic & Investigative Accounting ACIS 5124 Governmental and Nonprofit Accounting OR ACIS 5134 Mergers and Acquisitions Three hours of Finance to be determined in consultation with your advisor. Information Systems: ACIS 5014 Information Systems Audit and Control ACIS 5024 Ethical Issues in Accounting OR ACIS 5034 Global Issues in Accounting and Information Systems ACIS 5524 Advanced Database Management Systems ACIS 5534 Information Systems Development ACIS 5554 Applied Software Development ACIS 5584 Information Systems Security and Assurance ACIS 5594 Web-Based Applications and Electronic Commerce Elective (advance approval of advisor required)

GRADUATE COURSES (ACIS)

ACIS 5014:

Information Systems Audit and Control

This course explores the theories and practices of audit and control of computer-based information systems. Audit and control of information systems is examined from the viewpoint of management, systems professionals, and auditors. The rationale for controls, control theories, and audit practices are emphasized.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5514 OR ACIS 3504 (UG) OR ACIS 3504 OR ACIS 3515 (UG) OR ACIS 3515

Corequisite(s):

ACIS 5024:

Ethical Issues in Accounting

Roles of accounting in today's society include Accounting and the environment, corporate social responsibility, economic development,

sustainability, ethics, and distributive justice. Pre-requisite: Graduate

Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5104

Corequisite(s):

ACIS 5034:

Global Issues in Accounting and Information Systems

Accounting and information systems issues with emerging economies and the global business environment. Graduate standing and business core required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5104:

Fundamentals of Accounting

Fundamentals of accounting systems as they relate to decision making. Attention is directed toward accounting for the core of management control and financial reporting systems, and as integrally related to the information system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5114:

Advanced Accounting

In-depth analysis of business mergers and acquisitions, consolidated financial statements, translation and remeasurement of foreign currencies, partnership accounting, financial distress, and other selected complex financial accounting and reporting topics. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 3116 (UG) OR ACIS 3116

Corequisite(s):

ACIS 5124:

Governmental and Nonprofit Accounting

An analysis of current governmental and nonprofit accounting, budgeting, reporting, and auditing concepts, models, and practices. Identification and evaluation of alternative concepts and models will also be emphasized.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 3115 (UG) OR ACIS 3115

Corequisite(s):

ACIS 5134:

Mergers and Acquisitions

In-depth analysis of business mergers and acquisitions, including variable interest entities, multiple entity accounting, foreign currency transactions and financial statement translation and remeasurement; worldwide accounting diversity; and current issues in accounting. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 4114 (UG) OR ACIS 4114

Corequisite(s):

ACIS 5194:

Financial Statement Analysis

A comprehensive treatment of the analysis of financial statements as an aid to decision making. Primary attention is placed on investing and lending decisions as they affect the financial manager.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5104 OR ACIS 2115 (UG) OR ACIS 2115

Corequisite(s):

ACIS 5214:

Advanced Strategic Cost Management

To provide an understanding of advanced strategic cost management methods. The areas covered include topics in cost estimation, cost-volume-profit analysis, activity based costing, costing in new manufacturing environments, performance measurement, management control, and ethical implications.

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ACIS 3215 (UG) OR ACIS 3215 OR ACIS 4214 (UG) OR ACIS 4214), BIT 2406 (UG) OR BIT 2406

Corequisite(s):

ACIS 5294:

Management Control Systems

Analysis and design of control systems to facilitate short term decisions in order to allow management attention on long term strategic issues.

Such systems integrate financial, marketing, production, and other business policies in accomplishing the goals and objectives of an organization. Accounting techniques are the core of management control systems, and information systems provide necessary links. Includes impact of tax planning, financial reporting, and internal and external auditing systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5104 OR ACIS 2116 (UG) OR ACIS 2116

Corequisite(s):

ACIS 5314:

Tax Concepts and Research

Tax research process including analysis of fundamental tax concepts underlying interpretation and application of tax law, mechanics of tax research, written and oral communication of research results, tax planning, and practice and procedure before tax authorities. The course explores the sources and hierarchy of tax law and the interaction of law and its interpretation and application to contemporary tax issues, as well as the recognition of the impact on and opportunities for future tax planning. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 4314 (UG) OR ACIS 4314

Corequisite(s):

ACIS 5324:

Taxation of Business Entities

The tax aspects of forming and operating partnerships and corporations, and the sale and liquidation of a partnership interest. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 4314 (UG) OR ACIS 4314

Corequisite(s):

ACIS 5334:

Advanced Corporate Tax

Covers the tax aspects of corporate redemptions, liquidations, and reorganization. The law of consolidated tax returns will also be covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5324

Corequisite(s):

ACIS 5364:

Multi-jurisdictional Tax Concepts

Tax issues of business enterprises operating in multiple taxing jurisdictions; multi-state and international taxation will be discussed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 4314 (UG) OR ACIS 4314

Corequisite(s):

ACIS 5414:

Auditing Theory

An in-depth study of the auditing profession. Topics include professional standards, independence, business and risk analysis, regulation of the profession, and advanced reporting issues. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 4414 (UG) OR ACIS 4414

Corequisite(s):

ACIS 5444:

Forensic and Investigative Accounting

Forensic Accounting is a specialized area of accounting which uses accounting methods and financial techniques to assist in solving economic-based crimes. This course will provide students an opportunity to gain experiences in forensic accounting as well as commonly used computer forensic software and techniques. The focus is on litigation

support, fraud risk management, fraud investigation, and the related audit tools. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5504:

Information Systems Design and Database Concepts

This course is an introduction to design methodologies in information systems. Structured systems analysis and design methodologies are discussed. An introduction to database design methodologies is also included. Topics related to different database models and their implementation is discussed. Students are also required to design and implement information systems using appropriate computer software.

Pre: MBA/MACCT standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5514:

Management of Information Systems

An analysis of theories and practices used in the management of systems that generate information and decisions to coordinate and control business operations. Both the viewpoints of the manager and the systems professional are covered in this course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 1504 (UG) OR ACIS 1504

Corequisite(s):

ACIS 5524:

Advanced Database Management Systems

This course relates database theories and practices to concepts from other areas, such as programming languages, algorithms, data structures, and information systems. The relational, network, and hierarchical models are introduced. A major portion of the course deals with data manipulation languages for the relational model, design theory for relational databases, and query optimization.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ACIS 4514 (UG) OR ACIS 4514 OR ACIS 4515 (UG) OR ACIS 4515 OR ACIS 5504

Corequisite(s):

ACIS 5534:

Information Systems Development

Study of theoretical and pragmatic approaches to the development of computer-based information systems. The emphasis is on the management of the systems development process. Strategies for managing the complexity of information systems are explored. The building of logical and physical models of systems through traditional nonexecutable models and executable computer prototyping. Must have prerequisites or permission of the instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 4514 (UG) OR ACIS 4514 OR ACIS 4515 (UG) OR ACIS 4515 OR ACIS 5504

Corequisite(s):

ACIS 5554:

Applied Software Development Project

Application of system analysis, design, and implementation concepts, principles, and practices to a comprehensive system development project. A team approach is used to analyze, design, implement, and document realistic systems of moderate complexity. Use of project management methods, project scheduling and control techniques, formal presentations, walk throughs, and group dynamics in the solution of information systems problems. Development of a database to support the system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5524 (UG) OR ACIS 5524, ACIS 5534 (UG) OR ACIS 5534 (UG)

Corequisite(s):

ACIS 5574:

Design Strategies for e-Business Systems

Organization and management of data in the health care industry. Includes standards for electronic health records, healthcare enterprise systems architecture, health database design, existing database

platforms, data integration from multiple sources, and database accessibility. Analysis of health-care-related organizations from the perspective of multiple user groups including patients, technicians, nurses, physicians, clinics, hospitals, and insurance companies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): BIT 5564

Corequisite(s):

ACIS 5584:

Info Sys Security & Assurance

An examination of the concepts, technologies, and applications of security in information systems. Topics include cryptography; security and threats to computers, e-mail systems, and internet networks; intrusion detection systems; and e-business security. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ACIS 4554 (UG) OR BIT 4554 (UG)), ACIS 4534 (UG)

Corequisite(s):

ACIS 5594:

Web-Based Applications and Electronic Commerce

An examination of the concepts, technologies, and applications of electronic commerce. Topics include the world wide web as a platform for electronic commerce; intranets; electronic data interchange; electronic banking and payment systems; security and firewalls; software agents; and the social, legal, and international issues of electronic commerce. Must have completed the first year of the MBA program and the prerequisites to the Master of Accountancy program.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5514 (UG) OR ACIS 5514 OR BIT 5474 (UG) OR BIT 5474

Corequisite(s):

ACIS 5604:

Accounting Fundamentals

An introduction for practicing executives to financial accounting cycles and transactions, financial statement reporting, and internal managerial accounting and costing. This course is designed to give executives an

understanding of accounting systems, and to illustrate and highlight potential points at which the systems could be manipulated. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5614:

Implementing Management Controls

The management control process is designed to influence managers and other employees of an organization to implement the strategies of the organization. The activities of management control include: planning, coordinating, communicating, and evaluating. This course addresses the important role that accounting and other information play in this process.

Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5704:

Managing Information for Executive Decision Making

An overview of the theories, practices, and technologies used in the management of information systems for business decision making. Topics include use of information systems, electronic business, business intelligence tools and knowledge management, customer relationship management systems, data warehousing, virtual teams and organizations, and information security and privacy, and their role in improving organizational decision-making capabilities. Graduate standing in EMBA or PMBA program required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5954:

Study Abroad

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ACIS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ACIS 5994:

Research And Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ACIS 6004:

Accounting and Information Systems Research Methods

A doctoral level seminar emphasizing the understanding and application of research methods used in Accounting and Information Systems

Research. Course activities concentrate on initiating doctoral students to the perspectives, methods, techniques, and skills necessary for

conducting research in the Accounting and Information Systems disciplines. Topics covered include philosophy of science, the nature of theory, researchy methods, study design, and measurement. Students evaluate and present research from current journals, develop research proposals, and write a literature review for a topic of their choice.

Doctoral standing is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 5114

Corequisite(s):

ACIS 6014:

Behavioral Research in Accounting Seminar

A doctoral level seminar emphasizing the design and evaluation of research conducted in the behavioral research area of accounting. The primary emphasis is on behavioral decision theory and its applications to the accounting function. Primary seminar material is selected from recent journal articles and current working papers on relevant topics.

Requires development and presentation of research proposal related to behavioral research in accounting.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 6004 (UG) OR ACIS 6004

Corequisite(s):

ACIS 6024:

Financial Capital Markets in Accounting Seminar

A doctoral level seminar emphasizing the design and evaluation of research conducted in the financial capital markets area of accounting.

Concentrates on empirical markets-based research concepts and methodologies utilized in accounting. Primary seminar material is selected from recent journal articles and current working papers on relevant topics. Requires development and presentation of research proposal related to capital markets in accounting.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 6004 (UG) OR ACIS 6004

Corequisite(s):

ACIS 6504:

Seminar in Information Systems Research

A research seminar that focuses on contemporary topics in information systems. The course can be focused on a specific area of interest such as the philosophical foundations of information systems, cognitive issues in information systems, behavioral issues in information systems, group support systems, information systems project management, knowledge management, information visualization, or information systems development, or can be focused on a set of separate topics. Pre:

permission of instructor II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ACIS 6004 (UG) OR ACIS 6004

Corequisite(s):

ACIS 7994:

Research And Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BUSINESS ADMINISTRATION

Robert Sumichrast, Head

General Contact: mba_info@vt.edu

Graduate Program: <http://www.mba.vt.edu>

The Pamplin College of Business offers the Master of Business Administration (M.B.A.) degree. The college also offers the master of accounting and information systems, and the master of science in hospitality and tourism management. In addition, the doctor of philosophy (Ph.D.) in business administration is offered through the departments of Accounting and Information Systems; Business Information Technology; Finance, Insurance, and Business Law; Management; and Marketing. The Department of Hospitality and Tourism Management offers the doctor of philosophy in Hospitality and Tourism Management. Departments also offer the master of science (M.S.) in business administration in their specialties on a limited basis. Information specific to graduate degrees other than the M.B.A. is located under the associated department. Graduate degree programs offered by the Pamplin College of Business are fully accredited by the Association to Advance Collegiate Schools of Business (AACSB International) with the exception of the M.S. and Ph.D. in Hospitality and Tourism Management. Master of Business Administration The plan of study leading to the Master of Business Administration is a 50-credit program requiring a bachelor of Science or Bachelor of Arts degree from an accredited college or university. All students must have a personal

computer and keep its hardware and software up-to-date during the program. Full-time students need wireless laptop computers. The College of Business publishes minimum computer hardware and software standards each year. The M.B.A. is available at the Blacksburg campus, as well as at the Northern Virginia Center (through both executive and part-time program formats), and in Richmond/Roanoke through the Professional MBA program. Full-time students usually attend classes at the Blacksburg location and enroll in 12 to 16 credits per semester. Classes at the other locations are arranged to accommodate the needs of the working professional. The full-time program is cohort based; new students are only admitted fall semesters and generally take the same courses for the first two semesters of the program.

SPECIAL FACILITIES

The full-time program resides in Blacksburg on the main campus. Most classes are held in Pamplin Hall. The Professional MBA program holds monthly classes alternating between the Roanoke and Richmond Virginia Tech centers. The Executive MBA classes are held at the Virginia Tech Arlington Center in the Ballston district of the city. Evening MBA courses are held at the Northern Virginia Center in Falls Church.

Pamplin Hall

Academics and laboratories; west section completed 1952; dedicated Oct. 24, 1953. Cost \$884,070. East section completed Fall 1959; cost \$889,944. Building contains 165,918 sq. ft.

DEGREES OFFERED

MBA Degree

Offered In (National Capital Region, Roanoke, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GMAT (GRE for simultaneous degree programs)

All applicants, regardless of status or campus location, must submit the following: a completed application, official college transcripts, official Graduate Management Admission Test (GMAT) score or Graduate Record Examination (GRE) score, a professional resume, and the appropriate application fee. Persons desiring to attend the full-time or Professional MBA program should send these materials to the Virginia Tech Graduate School in Blacksburg. Applicants wishing to attend the part-time or EMBA program in the Northern Virginia Center should send materials directly to that center. Detailed information about current admission and program requirements (which are subject to change) are available from the MBA web site www.mba.vt.edu and at the MBA Programs Office in the Pamplin College of Business. International applicants are also required to submit TOEFL scores. The minimum standards for admission conform to the university requirements, however, applicants with scores below 100 IBT or 26 on either the speaking or listening dimensions will be required to complete an English language course at the Virginia Tech language institute prior to beginning classwork. Please see the MBA program website for more information. The full-time MBA requires 52 semester hours of course work and is structured so that students take only core courses during the first half of the program. The following courses are required:

Management of Information Systems or Computer-Based DSS; Analytical Framework for Business Managers; Dynamics of Organization Behavior; Managerial Statistics; Fundamentals of Accounting; Operations Management; Principles of Finance; Ethical Dimensions of Leadership; and Marketing Policy and Strategy. The second half of the program consists of concentration courses, electives, a required international elective, and the required capstone core course, Strategic Management. In addition, full-time students must complete a one-credit career-management course. Full-time students cannot exempt core courses or transfer credit for core courses to Pamplin from another institution in most cases. In addition to the MBA core, students take elective courses that may lead to an area of specialization called a concentration. The following concentrations are available: Finance; Organizational Management and Strategy; Information Technology; Marketing. Formalized simultaneous degree programs in collaboration with the Virginia College of Osteopathic Medicine, the Myers Lawson School of Construction, the Civil Engineering Department and the Industrial and Systems Engineering Program are also available.

BUSINESS INFORMATION TECHNOLOGY

Bernard Taylor, Head

Professors: Ralph Badinelli; Deborah Cook; Parviz Ghandforoush; Cliff Ragsdale; Terry Rakes; Loren Rees; Roberta Russell; Bernard Taylor; Christopher Zobel;

Associate Professors: Alan Abrahams; Jason Deane; Barbara Hoopes; Tabitha James; Lara Khansa; Raymond Major; Lance Matheson; Quinton Nottingham; Gang Wang;

Assistant Professors: Onur Seref;

Ralph Medinger Lenz Professor: Ralph Badinelli;

Verizon Professor: Deborah Cook;

Bank of America Professor: Cliff Ragsdale;

William C. and Alix C. Houchens Professor: Terry Rakes;

Arthur Andersen Professor: Loren Rees;

R.B. Pamplin Professor: Bernard Taylor; Christopher Zobel;

Graduate Contact: cliff.ragsdale@vt.edu

Student Handbook: http://bit.pamplin.vt.edu/graduate_programs.html

Graduate Site: http://bit.pamplin.vt.edu/graduate_programs.html

The doctorate offered through the Department of Business Information Technology is a full-time, four-year, residential program offering specializations in information technology, decision support systems, business analytics, and operations and supply chain management. Although the program emphasizes the study of technologies used in the creation, storage, exchange, analysis, and use of information in its various forms, considerable emphasis is also placed on the related disciplines of mathematical programming, stochastic processes, computer simulation, artificial intelligence, and statistics. Study of these topics requires that the student have a strong quantitative background. The primary goal of the program is to prepare graduate students for successful academic careers. This objective is realized through a flexible, research-oriented program of study that provides extensive interaction with a faculty of outstanding researchers and teachers.

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Responsibility for the administration of the doctoral program is shared by the Department of Business Information Technology and the university's Graduate School. General university graduate degree requirements, procedures, and policies, are available through the Graduate School's web site <http://www.grads.vt.edu/>. Applicants to the Ph.D. program in Business Information Technology must complete and submit scores for either the GMAT or GRE exam. All Ph.D. candidates must complete a minimum of 90 semester hours beyond the baccalaureate. This total must include a minimum of 60 semester hours of approved course work and no fewer than 30 hours of research and dissertation credits. At least 50 percent of all graduate course credits (excluding research and dissertation credits) must be earned at Virginia Tech. The program of study must also satisfy the following departmental requirements. 1. A minimum of 12 hours of graduate course work must be taken in the Department of Business Information Technology. 2. A minimum of nine hours of research methodology related course work must be completed. 3. At least two continuous years must be spent in residence on the Blacksburg campus as a full-time student. A minimum of 24 graduate-level semester credit hours must be earned during this period. 4. Successful completion of a departmental screening exams at the end of the first and second years of study. 5. Full instructional responsibility for a least one course during doctoral studies. Each student's formal program of study is prepared during the second or third semester of study. This plan is developed by the student in conjunction with the Ph.D. advisory committee. In formulating the program, attention is given to the candidate's prior academic preparation and career objectives. Typically, a significant number of credits are taken outside the Pamplin College of Business in the departments of computer science, electrical and computer engineering, industrial systems engineering, statistics, or others as needed.

GRADUATE COURSES (BIT)

BIT 5404:

Management Science

Study of selected topics in management science as they apply to managerial decision making. Topics include resource allocation using linear programming, transportation and assignment models, network models for planning and scheduling, queueing models for waiting line analysis, and an introduction to simulation modeling and analysis. Use of the computer for problem analysis and solution is emphasized. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5414:

Production and Operations Management in A Global Environment

Analysis of the role of operations management in modern organizations. Emphasis will be placed on the interaction of production and operations management with other functional systems in an organization. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5434:

Computer Simulation in Business

Investigation of computer simulation methodology and its application in the analysis of business systems. A high level simulation language will be used to develop simulation models for a variety of decision-making scenarios. Open to graduate students who have had introductory course work in computer programming and statistics. Pre: MBA students only or instructor's consent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5454:

Distributed Processing and Data Communications

This course surveys the field of computer networking and communications. Students will learn reasons for networking as well as the costs and potential problems. In addition to computers, the course discusses hardware for local and wide area connectivity and other specialized devices. Software coverage includes operating systems, network management tools, drivers and protocols. Students will learn the primary duties of a network administrator in the operation of a computer network and become familiar with network planning, implementation, and routine administration. Pre: MBA students only or instructor's consent. I,II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5464:

Object Oriented Programming for Business

This course introduces concepts of object oriented programming (OOP). Comparisons between competing systems will be discussed. Emphasis will be placed on the practical application of object oriented concepts to business programming problems. Use of an object-oriented language will be required. Graduate standing and competence in a high-level programming language. MBA students only or instructor's consent. I,II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5474:

Computer-based Decision Support Systems

This course explains the characteristics, use, and development of decision support systems (DSS) within the context of other business information systems. The process of designing and implementing decision support systems in business is discussed from both theoretical and practical standpoints. Students will learn various ways of measuring the success of DSS implementation as well as the difficulties associated with all such measures. Students will learn to use common software tools to develop a simple DSS and will learn to use the Internet as a decision making and productivity tool. Pre: Graduate student standing or instructor's consent. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BIT 5494:

International 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. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5495:

Foundations of Decision Support Systems

Study of the design and implementation of decision support systems (DSS) using a visual environment. Topics will include methods for data access, modeling and computation in a visual language, graphical display of support material and report generation methodologies, object sharing between software components, and the deployment of support systems within distributed environments. Distributed DSS topics will include client server systems, common object model methodologies, and distribution in a web-based environment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): BIT 5474 (UG) OR BIT 5474

Corequisite(s):

BIT 5564:

Healthcare Information Technology

Use of information technology in the health care industry. Topics address electronic health records, patient informatics, evidence based medicine, electronic prescribing and telemedicine. The use of these technologies to improve patient health and medical systems operations.

Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ACIS 4515, CS 2604

Corequisite(s):

BIT 5574:

Healthcare Data Management

Organization and management of data in the health care industry. Includes standards for electronic health records, healthcare enterprise systems architecture, health database design, existing database platforms, data integration from multiple sources, and database accessibility. Analysis of health-care-related organizations from the

perspective of multiple user groups including patients, technicians, nurses, physicians, clinics, hospitals, and insurance companies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIT 5564

Corequisite(s):

BIT 5594:

Web-Based Applications and Electronic Commerce

An examination of the concepts, technologies, and applications of electronic commerce. Topics include the world wide web as a platform for electronic commerce; intranets; electronic data interchange; electronic banking and payment systems; security and firewalls; software agents; and the social, legal, and international issues of electronic commerce. Must have completed the first year of the MBA program or the prerequisites to the Master of Accountancy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (ACIS 5514 (UG) OR BIT 5474 (UG)) OR (ACIS 5514 OR BIT 5474)

Corequisite(s):

BIT 5604:

Modeling Decision Making for Competitive Advantage

This course examines a number of topics in management science and their applications in dealing with managerial problem solving. Decision theory and optimization techniques such as decision-trees, linear programming, integer programming, networks and others are studied, modeled and solved from a managerial and applied perspective. Business and industry cases are used to demonstrate usefulness and effectiveness of the models constructed. Students use software to perform computational studies, obtain solutions, and analyze the results for problems and cases. Graduate standing required. Executive MBA and Professional MBA Students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5624:

Program Management and Project Leadership

This course introduces the fundamentals of program and project management, beginning with project definition and culminating in the post-project review. Students will learn techniques, terms, and guidelines that are used to manage cost, schedules, risk, group dynamics, and technical aspects throughout the life cycle of a project.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5634:

E-Business Innovation and Implementation

This course focuses on the strategic business analysis and key technologies that provide the foundation for e-business innovation and implementation. The course focuses on the technology that underlies the Internet and how firms compete and win in the information technology age. Emphasis is placed on concepts, frameworks, and approaches that enable a corporate manager to embrace the Internet technology and to conduct online business. In addition to the study of the web and Internet, other topics such as formulating e-business strategy, e-business models, customer interface, and business-to-business marketplaces will be covered. Executive MBA students only.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5644:

Management of Information for Business Decisions

This course illustrates a variety of statistical methods to collect and analyze data sets. Complex problems, both business and societal, are studied and analyzed for trends, patterns, relationships and other useful information. Statistical tools such as probability distributions, sampling, hypothesis testing, regression and times series analysis, simulation, and forecasting are studied from a practical and business perspective.

Business and industry cases are used to demonstrate the usefulness and effectiveness of the techniques used. Students use software to perform computational studies, obtain solutions, and analyze the results.

Pre: Graduate standing in Executive MBA or Professional MBA program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5654:

Project Management

This course introduces the fundamentals of project management, beginning with project definition and culminating in the post-project review. Students will learn techniques, terms, and guidelines that are used to manage cost, schedules, risk, group dynamics, and technical aspects throughout the life cycle of a project. Graduate standing required; Executive or Professional MBA students only

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5664:

Managing the Global Supply Chain

This course provides 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 and process analysis skills to improving the quality and productivity of business firms and their supply chain partners. Efficient methods for streamlining the flow of information, services and products across functions, enterprises, and global boundaries are studied. Issues in designing and managing a network of suppliers in a global environment are discussed. Pre: Graduate standing in Executive MBA or Professional MBA program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5724:

Managerial Statistics

Introduction to basic statistical (inference) tools necessary in managerial decision-making. Topics include, but are not limited to, descriptive statistics, elementary probability theory, sampling and sampling distributions, portfolio management, hypothesis testing, regression analysis, quality improvement, and Six Sigma concepts and methodology. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

42 Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BIT 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BIT 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BIT 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BIT 6414:

Current Topics in Management Science

Advanced study of selected current topics in information technology emphasizing professional journal articles. Student research should lead to publishable paper. Course may be taken multiple times. Pre: restricted to graduate students in the Department of Business Information Technology.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIT 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FINANCE

Vijay Singal, Head

Professors: Janine Hiller; Gregory Kadlec; Arthur Keown; Raman Kumar; Sattar Mansi; George Morgan; Douglas Patterson; John Pinkerton; Vijay Singal;

Associate Professors: Randall Billingsley; Vittorio Bonomo; John Easterwood;

Assistant Professors: Deniz Anginer; Ugur Lel; Tong Wang; Jin Xu;

Professor of Practice: Michael Kender;

Richard E. Sorensen Professorship in Finance: Janine Hiller;

R. B. Pamplin Professor of Finance: Gregory Kadlec;

R.V & A.F Oliver Professor of Investment Management: Raman Kumar;

Wells Fargo Professorship in Financial Risk Management: Sattar Mansi;

SunTrust Professor of Finance: George Morgan;

SunTrust Professor of Banking: John Pinkerton;

J. Gray Ferguson Professor of Finance: Vijay Singal;

R.B. Pamplin Professor of Finance: Arthur Keown;

Graduate Contact: zarabeth@vt.edu

Graduate Site: <http://www.finance.pamplin.vt.edu>

The Department of Finance, Insurance and Business Law offers graduate studies leading to three advanced degrees: the Ph.D., M.B.A., and M.S. in Business (with specialization in Finance). The M.B.A. degree is a non-thesis program managed by Pamplin College of Business, not individual departments. The Finance Department offers several upper level M.B.A. courses that allow students to pursue a concentration in Finance. More details about the M.B.A. program are available at <http://www.mba.pamplin.vt.edu>. The M.S. is a 30-hour non-thesis program designed for a limited number of highly qualified students who wish to undertake specialized training in finance. However, students are not always admitted to the M.S. program. The PhD program requires dissertation on an approved topic in finance and is designed to prepare students for academic careers in research-oriented schools of business. Accordingly, the program's primary focus is on research. Over the first two years in the program students develop their conceptual and empirical tool kits by taking a series of graduate level courses in Economics, Statistics, Econometrics and four semesters of doctoral seminars in Finance. Students are also required to write research papers after their first and second year in the program, in addition to the dissertation. They are also provided the opportunity to teach at least one course during the program. Thus the program aims to prepare them for the research and teaching missions of their academic career. As a small program with an enrollment of two or three a year, the students get plenty of personal attention from our department faculty which is nationally recognized for its contribution to research. More information may be found on the Finance webpage at <http://www.finance.pamplin.vt.edu/academics/phd/index.html>.

Students admitted into the program are required to have a master's degree, competitive GMAT scores, strong transcripts and letters of recommendation. The financial aid is provided for four years conditional on satisfactory academic progress. Additionally, the department provides a "Professional Development Fund" to each student to help defray costs of conference travel, journal submission fees etc. During the first two years students are required to take about 40 hours of course work including nine 3-credit courses in microeconomics, macroeconomics, statistics and econometrics, and four 3-credit doctoral seminars in finance --- two each in Corporate Finance and Investments. Additionally, the students sign up for at least 50 hours of Research and Dissertation credits over the four years, adding up to at least 90 credit hours required to graduate from the doctoral program. In addition to the course work the students are required to successfully present their first and second year research papers to the faculty to better prepare them for their upcoming dissertation. In the summer following the four semesters of course work students are required to pass a 2-day comprehensive exam in Corporate Finance and Investments. For the rest of their time in the program they work on their dissertation under the guidance of a dissertation chair and committee.

SPECIAL FACILITIES

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DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (79.0)

GMAT

The M.S. is a 30-hour non-thesis program designed for a limited number of highly qualified students who wish to undertake specialized training in finance. However, students are not always admitted to the M.S. program.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

GRADUATE COURSES (FIN)

FIN 5024:

Principles of Finance

Explores the basic concepts underlying the finance function, relevant to finance and non-finance majors. It provides an understanding of the firm's decision-making framework in the context of the economic environment (financial markets) in which the decisions are made. The specific topics covered, at a basic level, include investment decision under uncertainty, valuation, risk and return, market efficiency, portfolio theory, asset pricing, cost of capital, capital investment decisions, and futures and options markets.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5624, ECON 5504, ACIS 5104

Corequisite(s):

FIN 5034:

Internet Law and Policy

Intensive examination of public and private regulation of the Internet at the local, national, and international levels. The broad areas covered are Internet as a communication medium; privacy, security and trust; intellectual property; and electronic commerce. Specific topics include

freedom of speech, encryption, and distance education. The course will examine private means of regulation, national, and state policies and international perspectives of Internet law. Pre: Graduate standing or consent of instructor. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5044:

Asset Valuation

Focuses on techniques for the valuation of non-financial assets such as projects, business units, private and public firms. Specific topics include method of comparables, discounted cash flow methods and the real options approach to valuation.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5054:

Options and Futures

This course provides an introduction to Derivative Securities like Options, Futures, and Forwards. The specific topics covered will include the payoffs and profits of Puts, Calls, and Forward contracts, one period binomial option pricing model, the use of Black-Scholes option pricing model, the relationship between the Spot and Forward prices, and an introduction to Real Options.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5064:

Equity Markets

Examines the role and functioning of the equity markets. Specific topics include the market structure and securities trading, overview of investment companies, and equity valuation models with brief overview of statistical properties of equity returns.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5074:

Interest Rates

Analysis of the macroeconomic and macro-financial environment of interest rate determination. Attention will be paid to the role of both monetary policy and market forces. The course will also review and analyze the basic determinants of valuing fixed income instruments.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5084:

Analytical Framework for Business Managers

The course provides and analytical coverage of the concepts and principles that affect and govern a firm's relationships and interactions with its customers, suppliers (of goods, materials, services, and funds), competitors, employees, other organizations and the regulatory environment. The course is designed specifically for first semester MBA students and the coverage is from the perspective of a business manager. Topics covered include demand and supply analysis, individual choice, pricing strategies, market structure, monetary policy, and government regulation. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5094:

Financial Databases and SAS

The course provides and introduction to databases that are used for research in Finance and Accounting, and the use of SAS for data analysis. The course is designed for Ph.D., students in business.

Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5104:

Corporate Finance

Provides a broad coverage of the major policy making areas of a corporation. The course covers topics in capital investment policy, financing and capital structure policies, dividend policy, financial statement analysis, financial forecasting, and the basics of working capital management.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5114:

Interest Rates and Fixed Income Securities

Analysis of the macroeconomic environment of interest rate determination and monetary policy. Description and analysis of several classes of fixed income securities. Measurement and management of interest rate risk. Introduction to arbitrage-free term structure modeling and applications to the pricing and hedging of debt securities.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5124:

Investment Analysis and Portfolio Management

Examines the role and functioning of securities markets. Specific topics include the equity market, fixed-income securities market, and mutual funds. The course presents portfolio and capital market theory, the efficient markets hypothesis, institutional organization, and security valuation techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5134:

Investment Banking in A Global Environment

Examines advanced topics confronting investment banks as

intermediaries in the raising capital and corporate restructuring processes. The topics include the U.S. and international structure and regulation of investment banking, global market strategies, intermediation theories, corporate going public and raising capital in a global market, corporate restructuring transactions, investment banking innovations, municipal financing, and ethics. The course contains a strong analytical component and also uses case studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5164:

Advanced Corporate Finance

Covers advanced topics in the basic policy making areas of corporations and special topics in corporate finance. The advanced topics are presented in the framework of the more current theories of corporate finance. The course also has a strong applied component in the form of case studies and computer applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5104

Corequisite(s):

FIN 5184:

Currencies and Global Finance

Explores the international economic environment, including analyses of exchange rates, international monetary systems, contemporary currency regimes, and current financial crises. Examines a firm's exposure to various kinds of exchange risks and the methods and financial instruments used to manage those risks. Introduces global opportunities open to firms for raising capital, foreign investment in financial assets, and managing currency and interest rate risk.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5024

Corequisite(s):

FIN 5194:

Commerical Law and Professional Liability

46 Study of the Uniform Commerical Code, including negotiable

instruments, sale of goods, secured transactions and documents of title. Debtor-creditor relations, special topics in business organization law, and the law of professional liability. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 3055 (UG) OR FIN 3055

Corequisite(s):

FIN 5204:

Managing Corporate Capital Investment and Capital Structure

Explores value creation through capital investment and capital structure choices. The capital investment and capital structure policies of a corporation have a very significant impact on its value and this course explores how these policies are established in the framework of modern finance theory. The course has a theoretical component and an applied component in which the case method is used.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5044, FIN 5054

Corequisite(s):

FIN 5214:

Fixed Income Securities

Description and analysis of several classes of fixed income securities. Measurement, management, and pricing of interest rate risk and credit risk. Valuation of embedded options.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5054, FIN 5074

Corequisite(s):

FIN 5224:

Portfolio Management

This course focuses on portfolio management and asset pricing. Specific topics include portfolio theory, asset pricing models (Capital Asset Pricing Model, Arbitrage Pricing Theory, among others), market efficiency and performance evaluation.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5044, FIN 5064

Corequisite(s):

FIN 5234:

Venture Capital and Investment Banking

Explores the venture capital cycle 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. Comprises a conceptual component and an applied component in which the case method is used.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5044, FIN 5054

Corequisite(s):

FIN 5244:

Managing Corporate Risk with Derivatives

Identification of domestic and global risk management problems of corporations. Application of derivative contracts to the solution of corporate risk management problems. Use of real world examples and cases of risk management.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5054, FIN 5074

Corequisite(s):

FIN 5254:

Financial Institution Risks and Strategies

Emphasis on the major issues facing managers and owners of financial institutions, primarily commercial banks. Topics include the risks and rewards associated with granting credit, managing liquidity, interest rates/currency positions, technology, and sovereign borrowers. The role of capital adequacy and the interaction of other regulatory aspects of the environment with managerial strategies and owner interests are emphasized throughout the course. Students run a simulated bank for the full semester.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5044, FIN 5074

Corequisite(s):

FIN 5264:**Mergers and Acquisitions and Corporate Restructuring**

Focuses on the major aspects of merger and acquisition transactions: deal strategy, deal analysis and deal design. Additionally, it explores value creation through other forms of corporate restructuring, such as divestitures or sell-offs, spin-offs, equity carve-outs, leveraged recapitalizations and leveraged buyouts. The course uses the case methods as the primary mode for teaching.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5044, FIN 5064

Corequisite(s):

FIN 5284:**Free Markets, Individual Freedom, and Social Welfare**

Expose students to the various viewpoints on the role that free markets can and do play in promoting individual freedoms and enhancing social welfare. This course will explore the strengths and weaknesses of capitalism by critically evaluating the relationship between the economic efficiency achieved by capitalism and the attainment of social welfare objectives. The course will also examine the economic and social welfare implications of current issues that could include globalization, price controls, income inequality, outsourcing, corporate pricing power through monopoly/oligopoly, and government regulation of the economy.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FIN 5604:**Financial and Economic Environment of Business**

Provide an understanding of the principles that affect a firm's interactions with its customers, suppliers, competitors, employees, and other organizations, and the roles of monetary and fiscal policies in the overall economic environment. Study the basic principles and concepts underlying the finance function. Topics covered include demand and supply analysis, individual choice, pricing strategies, market structure, monetary and fiscal policies, and the role of the Federal Reserve in managing growth, employment, and inflation. Graduate standing required. Executive MBA and Professional MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5614:**Financial Modeling and Corporate Finance**

Provides coverage of the major financial decisions facing a corporate manager in a modeling framework. The specific topics covered are analysis of financial statements, financial planning, cost of capital and capital budgeting, capital structure, working capital management, dividend policy, and international financial management. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5624:**Valuation and Corporate Restructuring**

Explores value creation through corporate restructuring. Provides detailed coverage of alternative valuation methods and explores the major asset and liability restructurings undertaken by a firm. The specific topics covered are valuation techniques, mergers and acquisitions, spin-offs, divestitures/asset sales, leveraged recaps, and leveraged buyouts. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5634:**Legal and Ethical Issues in the High Technology Environment**

Intensive exploration of legal and ethical issues that affect the operation of business in the high technology, networked environment. Studies public and private regulation of business, emphasizing the networked environment. Explores the interrelationship of ethics and law, the duties of directors and managers, and decision-making under uncertain regulatory parameters. Included within these areas are; participating in the regulatory process, intellectual property, ethical frameworks, Internet privacy and security, and international perspectives. Executive MBA students only.

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5644:

Issues in Corporate Governance

Current issues and trends in corporate governance. Topics include overview of the corporation, stakeholder versus shareholder, board of directors, regulatory and legal environment, and executive compensation. Graduate standing in Executive MBA program required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5654:

Principles of Financial Management

Provide an understanding of the basic principles and concepts underlying the finance function, and the analytical tools for making financial decisions. The specific topics covered are Goals of a Corporate Firm and Agency Problem, Cash Flow Estimation and Financial Statement Analysis, Financial Assets and Markets, Time Value of Money, Risk and Return, Diversification and Capital Asset Pricing Model, Valuation of Stocks and Bonds, and Market Efficiency. Executive MBA and Professional MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5604

Corequisite(s):

FIN 5664:

Corporate Finance

Explores value creation through capital investment and capital structure choices. Provides an understanding of the impact of capital investment and capital structure policies on the value of a corporation. Includes a theoretical component and a strong applied component with cases and projects. Executive MBA and Professional MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5654

Corequisite(s):

FIN 5674:

Investments and Portfolio Management

Risk, return and portfolio theory, knowledge of equity and debt markets, derivatives, and management of investment portfolios. Introduction to equity and bond valuation, mutual funds, portfolio analysis, market efficiency, options, and futures. Executive MBA and Professional MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5654

Corequisite(s):

FIN 5684:

International Finance

International economic environment, currency regimes, and currency crises; analysis of foreign exchange rates. Firms' exposure to exchange risk and methods for managing risk. Executive MBA students only.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5654

Corequisite(s):

FIN 5734:

Legal and Ethical Issues in Innovation and Technology

Intensive exploration of legal and ethical issues that affect the operation of business in the high technology, networked, environment. Studies public and private regulation of business, emphasizing innovation and the networked environment. Explores the interrelationship of ethics and law, the duties of directors and managers, and decision-making under uncertain regulatory parameters, especially in evolving businesses.

Included within these areas are: participating in the regulatory process, intellectual property, ethical frameworks, privacy and security, and international perspectives. Pre: Graduate standing required. Professional MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5744:**Current Topics in Corporate Governance**

Current issues and trends in corporate governance. Topics include overview of the corporation, stakeholder versus shareholder, board of directors, executive compensation, ownership structure, committee assignments, regulatory and legal environment, and firm performance.

Graduate standing in the Professional MBA program required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5784:**Global Finance**

International economic environment, currency regimes, and currency crises; analysis of foreign exchange rates. Firms' exposure to exchange risk and methods for managing risk including competitive and transaction exposure. Global opportunities to raise capital and foreign investment vehicles. Professional MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 5654

Corequisite(s):

FIN 5894:**Final Examination**

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5954:**Study Abroad**

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

FIN 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIN 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FIN 6115:**Corporate Finance**

Analysis of financial decisions in the corporate firm under uncertainty and in the presence of agency costs, information asymmetries, incomplete markets, and taxation. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 6004

Corequisite(s):

FIN 6116:**Corporate Finance**

Analysis of financial decisions in the corporate firm under uncertainty and in the presence of agency costs, information asymmetries, incomplete markets, and taxation. I

Credit Hour(s): 3

Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): FIN 6004
Corequisite(s):

FIN 6125:

Investments

Advanced treatment of equity, debt, and speculative markets. Topics include security return distributions, market efficiency, mean-variance portfolio theory, capital asset pricing, arbitrage pricing, option pricing models, and futures markets. Theory and empirical evidence are examined. I,II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): FIN 6004
Corequisite(s):

FIN 6126:

Investments

Advanced treatment of equity, debt, and speculative markets. Topics include security return distributions, market efficiency, mean-variance portfolio theory, capital asset pricing, arbitrage pricing, option pricing models, and futures markets. Theory and empirical evidence are examined. I,II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): FIN 6004
Corequisite(s):

FIN 6144:

Advanced Topics in Finance

Advanced topics of contemporary interest in finance. The course can be focused on a single area such as financial derivatives and risk management, mergers and acquisitions, investment banking, global financial markets, or financial regulation, or can reflect a combination of topics from several areas. Pre: Three credits in 6000 level FIN courses and consent of instructor.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):

Corequisite(s):

FIN 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

FIN 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

HOSPITALITY &, TOURISM MANAGEMENT

Nancy McGehee, Head

Professors: Mahmood Khan; Nancy McGehee; Suzanne Murrmann; Richard Perdue; Muzaffer Uysal;

Associate Professors: Vincent Magnini;

Assistant Professors: Candice Clemenz; Manisha Singal; Kimberly Soulek; Zheng Xiang;

J. Willard and Alice S. Marriott Junior Faculty Fellow for Hospitality

Management: Nancy McGehee;

R.B. Pamplin Professor of Hospitality and Tourism Management: Richard Perdue;

Associate Professor of Practice: Richard Parsons;

General Contact: htmcpt@vt.edu

General Contact: blovern@vt.edu

Student Handbook: <http://www.htm.pamplin.vt.edu>

The Virginia Tech Hospitality and Tourism Management (HTM) graduate program is consistent with the mission of a comprehensive research university; our program emphasizes developing student ability to generate new knowledge through research. HTM is one of six departments in the Pamplin College of Business. Our vision, which permeates throughout our graduate program, is to be the premier business education and research program in hospitality and tourism management. Our graduate program is widely recognized as one of the premier programs of its kind in the nation. Graduates are prepared for

challenging careers in academic and/or industry positions in hospitality and tourism management. Two principles permeate our graduate programs. First, one of the most important dimensions of the graduate program is its focus on the application of theories and methodologies from a variety of disciplines to hospitality and tourism management. The department provides extensive opportunities for graduate students to partner with faculty to conduct research on significant industry problems. Second, the program is customized to the student's interests; degree candidates and their advisory committees plan individual graduate programs pursuant to the students' career goals and degree requirements. For graduate students at the Masters level, the program provides an opportunity for growth as a student and as a career-directed individual. The goal is to provide middle management personnel, consultants and researchers to the hospitality and tourism industry. This goal is accomplished by providing a stimulating environment that encourages seeking knowledge and applying it to the needs of the industry. Fulfillment of the goal occurs as a result of considerable interface and focus, in the classroom and out, with industry and educational leaders on issues of immediate and long-term importance to the industry. At the Ph.D. level, the program provides an understanding of the body of knowledge in hospitality and tourism management and develops abilities to achieve scholarly success. These abilities include competency in research/problem solving and teaching/communication. Ph.D. candidates are expected to recognize and maintain the highest standards of academic/scholarly performance. The goal of the program is to provide superior educators, researchers and scholars to top tier university programs in hospitality and tourism management. This goal is accomplished by creating a scholarly research environment which makes available to the student opportunities for writing, publishing, research, consulting and teaching.

SPECIAL FACILITIES

Facilities

Virginia Tech is a comprehensive research university with modern technology, computing, and library resources. The Department of Hospitality and Tourism Management occupies the third floor of Wallace Hall on the main Virginia Tech campus. Graduate program facilities include private carrels for the Ph.D. students and many MS students. There is a computer lab dedicated to the graduate program, providing access to a full range of office, graphical, scientific, and statistical software. All graduate classes are taught in a dedicated classroom with comprehensive technological equipment and software. The Department partners with the Inn at Virginia Tech, the Virginia Tech Dining Service, and the local and regional hospitality and tourism industry to provide research and internship opportunities.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

IELTS: (6.5), (0.0)

iBT: (100.0)

At both the MS and Ph.D. levels, the student's plan of study is designed and approved in conjunction with a graduate advisory committee comprised of a chair and a minimum of either two (MS) or three (Ph.D.) graduate faculty members. On admission into the graduate program, an initial advisory committee is assigned by the Graduate Program Director. The student has the ability to change this committee after s/he has the opportunity to better know the faculty and articulate her/his interests. The following reflects the general framework of the MS plans of study. Master of Science Hospitality and Tourism Management Thesis Option (37 credit hours) 15 HOURS in Hospitality Management Core Courses HTM 5424 Human Resource Management HTM 5444 Financial Management in Hospitality Service Industries HTM 5454 Hospitality Marketing Strategy and Policy HTM 5514 Contemporary Problems in the Hospitality Industry HTM 5534 Strategic Management and Competitive Strategy in the Hospitality Industries 3 HOURS of Statistics STAT 5615 Statistics in Research (or other comparable course) 3 HOURS of Methodology HTM 5544 Research Methods for Hospitality Applications 9 HOURS in Selected Area of Specialization 6 HOURS of Research and Thesis HTM 5994 Research and Thesis 1 HOUR of Graduate Seminar in Hospitality and Tourism Management HTM 5944 Graduate Seminar Master of Science Hospitality and Tourism Management Non-Thesis Option (37 credit hours) Those interested in further graduate work after the MS should select the thesis option. 15 HOURS in Hospitality Management Core Courses HTM 5424 Human Resource Management HTM 5444 Financial Management in Hospitality Service Industries HTM 5454 Hospitality Marketing Strategy and Policy HTM 5514 Contemporary Problems in the Hospitality Industry HTM 5534 Strategic Management and Competitive Strategy in the Hospitality Industries 3 HOURS of Statistics STAT 5615 Statistics in Research 3 HOURS of Methodology HTM 5544 Research Methods for Hospitality Applications 15 HOURS in Selected Area of Specialization To include at least 6 hours of HTM courses plus HTM 5904 Project and Report (3 cr) 1 HOUR of Graduate Seminar in Hospitality and Tourism Management HTM 5944 Graduate Seminar NOTE: 1. Courses are taken in consultation with the student's advisory committee and approval of the Head of the Department. 2. Courses cannot be counted twice under any of the above mentioned categories. 3. No more than 9 hours can be taken as independent study courses. 4. Consult graduate catalog for the number of courses that can be transferred.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

IELTS: (6.5)

iBT: (100.0)

At both the MS and Ph.D. levels, the student's plan of study is designed and approved in conjunction with a graduate advisory committee comprised of a chair and a minimum of either two (MS) or three (Ph.D.) graduate faculty members. On admission into the graduate program, an initial advisory committee is assigned by the Graduate Program Director. The student has the ability to change this committee after s/he has the opportunity to better know the faculty and articulate her/his interests. The MBA program is administered by the graduate faculty at the National Capital Region campus. The following reflects the general framework of the Ph.D. plans of study. Ph.D. Program Hospitality and Tourism

Management(90 Credit Hours)The specific courses in the Ph.D. program will be identified in consultation with the student's graduate committee. The general categories of courses are as follows: 12 HOURS: Hospitality Research and Theory CoreHTM 5944 Graduate Seminar (must be taken four times for 3 hours credit)HTM 6434 Theory Development for Hospitality & Service Management HTM 6444 Advanced Quantitative Methods for Hospitality Applications HTM 6464 Review of the Research in Hospitality and Tourism Management 3 Hours: Statistics / Methodology15 Hours: Selected Area of Specialization A minimum of 6 hours must be HTM courses. At least two 6000 level courses.30 Hours Dissertation (HTM 7994)NOTE:1. Courses are taken in consultation with the student's advisory committee and approval of the Head of the Department.2. Courses cannot be counted twice under any of the above mentioned categories.3. No more than 9 hours can be taken as independent study courses.4. Consult graduate catalog for the number of courses that can be transferred.

GRADUATE COURSES (HTM)

HTM 5024:

International Service Management

Overview of the contemporary issues in the international business environment facing multinational service firms in the hospitality industry.

These issues include such topics as: global strategy formulation, and implementation; technology challenges; diversity in customers and employees; political and legal concerns; and effective organizational structures for long term survival.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5424:

Human Resource Management

This course focuses upon the attainment and retainment of employees within the hospitality industry. Topics include the processes, practices and legal considerations involved in the employment of people in hospitality organizations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 3334

Corequisite(s):

HTM 5424G:

Event Mgmt-Soc Sci Perspective

Examines event tourism from a theoretical, sociological, societal,

economic and community impact perspective including a review of select theories in the context of event tourism. Addresses multiple event organizational components and event legacy impacts via multiple learning strategies. Utilizes global mega-events such as the Olympic Games and World Cup football as models for discussion. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5444:

Financial Management in the Hospitality Service Industries

Fundamentals of financial management as applied to hotel, restaurants, institutions and similar service organizations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIN 3104

Corequisite(s):

HTM 5454:

Hospitality and Tourism Marketing Strategy and Policy

Examination of the role of marketing within the strategic planning of hospitality service organizations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 3104

Corequisite(s):

HTM 5464:

Franchising in Hospitality Management

Role of franchising in hospitality management. Contemporary issues related to franchising in different segments of hospitality industry, including franchise concept development, franchisor-franchisee relationship, franchise agreements, operational problems, and international franchising. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5514:

Contemporary Problems in the Hospitality Industry

Consideration and analysis of relevant industry problems and issues facing management personnel in the hospitality industries. Computer literacy required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5534:

Strategic Management and Competitive Strategy in the Hospitality Industries

To enable students to develop a comprehensive understanding of the concepts of strategic management and competitive strategy as applied to the hospitality industries.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HTM 4534

Corequisite(s):

HTM 5544:

Research Methods for Hospitality Applications

The use of business research methods in the scientific investigation of hospitality related problems. The foundations of research, research design, data collection techniques, sampling issues, statistical techniques and the analysis and reporting of data will be studied.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5634

Corequisite(s):

HTM 5554:

Qualitative Research Methods in Business

This course focuses on the key components of qualitative methodology for research applications in business. The course introduces students to the basics of qualitative research in the business context as well as the ontological and epistemological foundations of qualitative research. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5614:

Current Issues in Travel and Tourism Management

Current issues in the management of travel and tourism services. Environmental trends, planning and development, policy formulation, social and economic impact, and marketing of travel and tourism.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HTM 5944:

Graduate Seminar

Presentation and critical discussion of current literature and major topics in hospitality and tourism management. The seminar provides a forum for the discussion of research and research problems in hospitality and tourism management and the presentation of research by graduate students. Provides students an opportunity to prepare and present current work related to their thesis and dissertation activities. May be repeated.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 5954:

Study Abroad

54 Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HTM 5964:

Field Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HTM 5974:

Independent Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

HTM 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HTM 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

HTM 6414:

The Concept of Service in the Hospitality Service Industries

Seminar in the concept of service and its management.
Credit Hour(s): 3

Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): HTM 5514
Corequisite(s):

HTM 6424:

Human Resources Management in the Service Industry

Examination of research and writings in the area of human resources management in service industries. Issues and opportunities in human resources management distinctive to hospitality service organizations.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): HTM 5424 OR MGT 5704
Corequisite(s):

HTM 6434:

Theory Development for Hospitality and Service Management

Seminar in theory construction in the areas of hospitality, tourism and service. Emphasis on the identification of relevant interdisciplinary paradigms and theory and the evaluation of social science research. Six graduate credits of hospitality and tourism courses required. Alternate years. I
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HTM 6444:

Advanced Quantitative Methods for Hospitality Applications

Methodologies and techniques for analysis, reporting, and critiquing hospitality issues using advanced concepts and quantitative methods in the scientific investigation of problems related to hospitality.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 6634
Corequisite(s):

HTM 6454:

Hospitality Marketing Research Problems

industry marketing problems. Analysis and interpretation of marketing research studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HTM 5454, STAT 5634

Corequisite(s):

HTM 6464:

Research Foundations in Hospitality and Tourism Management

Advanced survey of classical and current literature in hospitality and tourism management. Tools to assess research questions, opportunities, and limitations of the research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HTM 5544

Corequisite(s):

HTM 6534:

Advanced Seminar in Strategic Management in the Hospitality Industry

This seminar is designed to provide an in depth exploration of the literature and research which has been developing in the context of the hospitality and tourism industry, specifically as it applies to the hotel, restaurant, and tourism sectors. Specific methodological approaches encountered in an industry specific environment will be identified and evaluated. The current state of theory development will be assessed and key issues relevant to further theory building will be explored. The course will be in a seminar format where students will be expected to develop a comprehensive and in-depth understanding of the body of knowledge relative to strategy in the hospitality and tourism industry. Must have the prerequisite or equivalent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HTM 5534

Corequisite(s):

HTM 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HTM 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MANAGEMENT

Kevin Carlson, Head

Professors: Kevin Carlson; Devi Gnyawali; Steven Markham; Anju Seth; Richard Wokutch;

Associate Professors: Jeffrey Arthur; Daniel Beal; Anthony Cobb; John French; Donald Hatfield; Wanda Smith; Linda Tegarden; Ryan Zimmerman;

Assistant Professors: Olga Bruyaka; Richard Hunt; Marc Junkunc; Pooja Thakur Wernz; David Townsend; Anna Ward Bartlett;

Pamplin Professor: Devi Gnyawali; Anju Seth; Richard Wokutch;

Digges Professor: Steven Markham;

Graduate Program: segiles@vt.edu

Graduate Program Director: devi@vt.edu

Graduate Program:

<http://www.management.pamplin.vt.edu/academics/phd/index.php>

Ph.D. Program Policies:

http://www.management.pamplin.vt.edu/academics/phd/Policies_and_Procedures_2012_Final_Version.pdf

The Ph.D. program in Business Administration with a major in Management in the Pamplin College of Business is dedicated to preparing men and women who will be among the next generation of research faculty at top academic institutions. The faculty of the Department of Management is committed to Ph.D. mentoring. That commitment is shown in a vibrant curriculum and an apprenticeship style that provides students opportunities to work closely with faculty. Our approach to doctoral education is unique. We emphasize preparation of students in ways that allow them to understand and address the whole organization from the study of individuals and groups within organizations to how they operate strategically in the larger business environment. Our program allows students to develop the knowledge and skills necessary to address the critical and complex questions faced by organizations today those that require expertise that cuts across the boundaries of current organizational research disciplines. One of the core strengths of our program is the possibility for the students to

integrate micro and macro literatures to examine the phenomena of their research interest. Our curriculum emphasizes a solid foundation in strategic management, organization theory, organizational behavior, human resources management, and ethics and social responsibility. Students develop a solid understanding of management through four core management courses, and then they specialize in any of these areas based on their research interests. In addition, students acquire and develop skills in research design, measurement, and statistical analysis that will allow them to be effective, independent researchers for their academic careers. Our doctoral students engage in close and collegial research collaboration with our faculty who are highly respected nationally and internationally based on their research excellence. The student-faculty research collaborations continue years after the students' graduation from the program. Our faculty has a strong commitment to teaching and Ph.D. mentoring. That commitment is shown in a vibrant curriculum and steady increases in the productivity of our graduate students. We view a doctoral education as the foundation for lifelong learning. We develop excellence in our students so that they can make significant scholarly contributions throughout their careers.

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

The Ph.D. program in Business Administration with a Major in Management prepares students for an academic career in university research. To be considered for entry into the program students must have completed a Masters Degree, typically an MBA or its equivalent. The doctorate is designed as a residential four-year program that offers a series of foundation seminars that integrate theory and research in strategic management, organization theory, and organization behavior. After completion of basic seminars, students may specialize in any of several management sub-disciplines. Students must also complete a minimum of one semester as a teaching assistant in preparation for their future roles as instructors. The Ph.D. degree in Management requires students to prepare a dissertation and considerable time is spent working toward this degree is devoted to research. Specific requirements for degree completion can be found in the general requirements for the Ph.D. as provided in the sections of this catalog entitled Requirements for the Doctor of Philosophy (Ph.D.) and in the Policies and Procedures for the Ph.D. Degree in Business Administration with a Major in Management

GRADUATE COURSES (MGT)

MGT 5124:

Business Research Methods

foundations of research methodology in business. Integrates research

design, basic measurement and data analytic skills. Develops an understanding of quasi-experimental designs as a foundation for higher coursework in research design, measurement, and statistical analysis for business research. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5314:

Dynamics of Organization Behavior

This course examines the determinants and consequences of human behavior in formal organizations. The specific graduate focus is on understanding the individual, interpersonal, and group processes which underlie all human dynamics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5334:

Managing Change Through Leadership: Individual and Team Development

This course examines techniques for successfully managing change in formal organizations through a variety of individual and team based methods. Both practical techniques and theoretical perspectives for leadership development will be emphasized within the context of improving organizational effectiveness. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5314

Corequisite(s):

MGT 5384:

Ethical Dimensions of Leadership

This course examines conduct in business within the context of moral philosophy. Emphasis is placed on the relevance of philosophical theories of morality to leadership and decision making in organizations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5394:

Current Policy Issues in Personnel and Labor Relations

Consideration and analysis of relevant current policy issues in the fields of personnel management and labor relations. Emphasis both on macro policy issues and their implementation at organization level.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5404:

MBA Career Planning

This course is designed to improve career success and satisfaction of MBA students. Students use the Success-Related Observable Behaviors Model (SROB) to identify behaviors that are critical to their chosen career roles. Students assess their mastery of those behaviors with which to improve the effectiveness of their career search through changed behaviors or changed objectives. Strategies for developing networks of individuals and organizations are covered. Assignments emphasize a progressive process for creating a features profile that differentiates the student's self-promotion from that of competitors. MBA students only. Must be enrolled in first semester MBA core courses.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5414:

MBA Job Search Strategy

The Success-Related Observable Behaviors (SROB) model will be used to understand role-specific interviews. Also introduced are alternate interview concepts, such as the case interview, industry/field targeted interviews, and panel interview strategy. Legal vs. illegal interview questions and how to respond to them without impairing one's candidacy are covered. Students learn how specific salary offers are determined given a company's job evaluation approach and hiring philosophy. The concept of "basis" for salary negotiation is introduced, as well as appropriate responses to low offers allowing for further negotiation. The ethics of recruitment is addressed, including ethical behavior

expectations for candidates, recruiters and career services

professionals. MBA students only. Must have completed the first year of MBA core courses.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5404

Corequisite(s):

MGT 5424:

Business Negotiation: Strategies, Tactics and Skills

Examines negotiating as a process where two or more parties seek to build upon their common interests and manage their divergent ones. Both the context of negotiations and the skills of the parties in rational analysis and interpersonal relationships determine whether an agreement can be reached and the quality of the outcomes for the participants. Extensive use is made of simulated negotiation exercises followed by analysis of outcomes to enable students to practice applying concepts and theories developed by economists and social psychologists to concrete business cases. Pre-requisite: Graduate standing in the MBA program

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5434:

Diversity in the Workplace

This course examines the impact of diversity, culture, and ethnic origin on the work experience, and is designed to prepare individuals to meet the challenge of cultural diversity in organizations. Attention is given to how gender, race, religion, age, social class, sexual orientation, culture, tradition, education, economic structure, and organizational philosophy interact to create a set of rules for acceptable behaviors in complex organizations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5444:

The social context of business, with particular attention to marketing practices and entrepreneurial ventures. Examination of the public policy issues that arise from the pursuit of capitalist enterprise as well as the role of marketing and entrepreneurship in advancing social welfare and economic development. Multi-disciplinary approach linking historical, socio-cultural, political/legal, ethical, and strategic analyses in a global context.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104, MGT 5314

Corequisite(s):

MGT 5454:

International Business

Challenges and opportunities for multinational corporations in the global economy. Sociocultural, economic, political, and legal environments of international business. Strategies for creating competitive advantage globally. Analytic and managerial skills for international business functions. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5464:

Corporate Acquisitions and Alliances

Modes to accomplish the firm's corporate strategy and create corporate advantage, including mergers, acquisitions, alliances, joint ventures and corporate restructuring. Analytic and managerial skills for managing corporate development in traditional, large business settings in developed economies as well as in start-ups, the Internet/new economy and emerging economies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5314

Corequisite(s):

MGT 5524:

Business Negotiations

This course addresses the practice of successful negotiations in

business, including the business activities of marketing, operations, finance, and information management. This course utilizes behavioral principles of negotiation to develop and refine students' understanding and practice of effective negotiating skills. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5594:

Technology and Innovation Management

This course takes a general manager's perspective to examine the challenges of managing technology and innovation and their impacts on organizations. It provides students with a solid understanding of key concepts, tools, and frameworks useful in managing technology and innovation. Cases will also be used as a device for developing analytical and decision-making skills and for highlighting the reality of organizational and environmental complexities in managing technology and innovation. Pre-requisite: Enrollment in the Exec. or Prof. MBA program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5604:

Team Building

An introduction to teams in management including the justification for team formation. Practical considerations for developing teams to improve personal and organizational effectiveness are covered, particularly in organizations where significant diversity is present. Executive MBA students only.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5614:

Designing & Managing Orgs

This course focuses on the implications of globalization and the resulting cross-cultural relationships for leaders and managers of business

organizations. The ways in which culture affects characteristics of individuals, interpersonal relationships, negotiation styles, and leadership practices are examined. Cases and exercises develop skills in applying theories and concepts to concrete situation. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5634:

Strategic Business Environment

Course focuses on tools and techniques for industry and competitive analysis and describes methods used by organizations to develop and sustain a competitive advantage. Examples and cases from current business, single- and multi-business corporations in a variety of industries will be studied. Executive or Professional MBA program required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5644:

Issues in Corporate Governance

Current issues and trends in corporate governance. Topics include overview of the corporation, stakeholder versus shareholder, board of directors, regulatory and legal environment, and executive compensation. Graduate standing in Executive MBA program required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5654:

Strategic Human Resource Management

Examines current issues critical to the management of an organization's human capital assets. Critically examines how systems of human resource policies and practices can be used to enhance a firm's competitive strategy and achieve competitive advantage in the marketplace. Examines development and deployment of systems of

human resource practices appropriate to specific organizational objectives and their impact on organizational effectiveness. Prerequisite: Enrollment in the Professional MBA or the Executive MBA program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5664:

Ethical Leadership in a Global Context

This course examines significant issues in business ethics and the forms they take in different cultures. A stakeholder approach is adopted and attention is focused on firms' relationships with four important stakeholders: employees, consumers, governments, and communities. Skills at stakeholder analyses are developed through the application of various ethical theories to case studies of problems encountered in different cultures. Creativity in resolving conflicts among stakeholders with different values and interests is fostered through participation in experiential negotiation exercises. Graduate standing required. Executive MBA and Professional MBA students only.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5674:

Leadership for Change Management

Study methods for changing organizations and individuals within those organizations using organizational transformation techniques, information technologies, and different leadership/personality styles. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5684:

Global Management and Strategy

Management challenges associated with global competition and the ways in which firms can create and sustain superior returns be

formulating and implementing effective strategies. Develops an integrated, multi-functional, "general management" perspective of the organization. Comprehensive case studies of large firms will be used to develop students' skills in strategic thinking, analysis, and execution.

Strong emphasis is placed on the global environment. Pre-requisite:

Enrollment in the Executive MBA program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5694:

Seminar in Current Business Issues

This course will address current issues in business with content changing each time it is offered. Topics may include theoretical, conceptual and practical concerns in business related functions such as accounting, information systems and technology, finance, management or marketing. Executive MBA students only.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5714:

Human Resource Staffing and Development

This course is designed to integrate theoretical, legal, and pragmatic considerations pertaining to the acquisition, deployment, and development of human resources within organizations (public and private sector). The course adopts a management perspective in which emphasis is placed on the design and implementation of staffing and development processes to achieve organizational objectives within social and economic constraints.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5724:

Compensation and Rewards Systems

Study of employee compensation theory and practice in private and public sector organizations. Special emphasis is placed on wage and

incentive program design techniques and administrative considerations, and their theoretical justifications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5744:

Topics in Corporate Governance

Current issues and trends in corporate governance. Topics include overview of the corporation, stakeholder versus shareholder, board of directors, executive compensation, ownership structure, committee assignments, regulatory and legal environment, and firm performance.

Graduate standing in the Professional MBA program required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5764:

Applied Human Resource Information Systems

Applied human resource information systems is the study of how human resource information systems (HRIS) can and should be applied in organizations to support organization strategy, improve efficiency and flexibility, increase productivity, and improve the quality of work life for all employees. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5784:

International Management

This course focuses on the management challenges associated with the development of strategies and the management of organizations in business enterprises whose operations stretch across national boundaries. It will provide students with the knowledge, skills, and sensitivities that will help them manage more effectively in an international environment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5314

Corequisite(s):

MGT 5794:

Strategic Management

Examines business policy through a study of general management's task of strategy formulation and implementation. Comprehensive case studies concerning a variety of organizations serve as a basis for analysis. Pre: Final term M.B.A. standing. I,II,III.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5804:

Strategic Leadership in Technology-based Organizations

This course focuses on the role of the leader in crafting corporate and business strategies where technology provides the basis for the firm's competitive advantage.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

MGT 5814:

Entrepreneurial Leadership

Concepts and techniques for providing leadership in the entrepreneurial venture. Provides the theoretical understanding of the entrepreneurial process in the economy as well as the practical leadership, marketing, financial and production considerations for entrepreneurial initiatives for new ventures and established firms.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5824:

Advanced Leadership: Skills & Concepts

This cornerstone course provides innovative experiences, skills, and

knowledge in leadership for MBA students. 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: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5314

Corequisite(s):

MGT 5834:

Essentials of Management of Technology

This course focuses on providing MBA students with a thorough understanding of the managerial issues, processes, tools, and skills necessary for the effective organization and management of technology (MOT). The goal is to help students develop an awareness and appreciation of the complex task of managing technology at the micro-level of the organization. An in-depth examination of the nature of MOT as both a discipline and a practice will be emphasized. The course will focus on analyzing the central issues involved in managing the four subsystems of MOT: (1) Research and Development (R&D) Management; (2) Product Technology Management; (3) Process Technology Management; and (4) Intellectual Capital Management. The course's domain will be both the service and manufacturing industrial sectors.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5844:

Business & Corporate Strategy

Focus on strategic decisions of the firm and use of tools and techniques for external and internal analysis to develop and sustain a competitive advantage. Examples and cases of single and multi-business corporations in a variety of industries, both domestic and international. Pre-requisite: Enrollment in Executive MBA program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5854:

Ethics and Leadership in a Global Environment

Ethical issues in business and management using both a theoretical and a case study approach. Relevance of philosophical theories of morality and alternative views of corporate social responsibility to leadership and decision making in organizations. Pre: Graduate Standing.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5954:

Study Abroad

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5964:

Field Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

MGT 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MGT 6104:

Advanced Research Studies

Students will carry out a theoretical or empirical research project, produce a research paper, present the research findings to the departmental faculty and students, and submit the manuscript for presentation at a professional meeting or for publication in an academic journal. Pre: Six hours of graduate statistics, completion of the first year of the management doctoral program.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6154:

Management Research Methods

Addresses the skill sets necessary to identify and summarize bodies of literature, quantitatively evaluate what has been learned from existing research, and identify research questions that represent the next logical steps in gaining understanding of the outcomes in question. Also

reporting practices on the development of research literature. Pre: 6

Hours of Graduate Statistics

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6305:

Seminar in Strategic Management

An analysis of activities that fall within the purview of general management and which typically relate to the firm as a whole. Special emphasis is placed on that research dealing with the tasks and responsibilities of general management and currently evolving subjects.

I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5794

Corequisite(s):

MGT 6306:

Seminar in Strategic Management

An analysis of activities that fall within the purview of general management and which typically relate to the firm as a whole. Special emphasis is placed on that research dealing with the tasks and responsibilities of general management and currently evolving subjects.

I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5794

Corequisite(s):

MGT 6315:

Seminar in Organization Behavior

A study of the nature of organization behavior and the processes pertinent to organizational effectiveness. The first course deals with the classical theory while the second concerns itself with current research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5314

Corequisite(s):

MGT 6316:

Seminar in Organization Behavior

A study of the nature of organization behavior and the processes pertinent to organizational effectiveness. The first course deals with the classical theory while the second concerns itself with current research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5314

Corequisite(s):

MGT 6324:

Teaching Ethics and Social Issues

This course provides students with a basic overview of the field of business ethics/social issues in management, including consideration of pedagogical techniques and teaching materials. The purpose of the course is to prepare doctoral students in management to be able to integrate consideration of ethical and social issues in business into the management courses they teach.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6325:

Seminar in Organization Theory

A thorough chronological and analytical study of the development of organization theory which concentrates on macro-level organizational issues from its genesis to the present day. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5324

Corequisite(s):

MGT 6326:

Seminar in Organization Theory

A thorough chronological and analytical study of the development of organization theory which concentrates on macro-level organizational issues from its genesis to the present day. I,II

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5324

Corequisite(s):

MGT 6344:

Seminar in Social Issues in Management

Examination of the role of business in society as defined by its relationships with consumers, employees, stockholders, government, and other corporate stakeholders. Emphasis is on examination of and learning to do research on the relationships between business and these stakeholders. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MGT 5384

Corequisite(s):

MGT 6364:

Advanced Seminar in Labor Relations

Examination of various aspects of labor relations from both a macro and micro perspective with emphasis on contemporary labor theories and their application in the labor-management interactions. May be repeated once.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6374:

Seminar in Advanced Topics in Human Resources Management

A course designed for doctoral students with a special emphasis on existing research and writings which contribute to understanding the constraints and opportunities for effective management of the human resource.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6384:

Topics in Business Ethics

This course, through coverage of varying topics, is designed to develop knowledge of the moral dimensions of business. Coverage includes major philosophical theories of morality and the place of ethics in business.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6704:

Strategic Management and Organization Theory Seminar

Current and classical theories in strategic management and organization theory will be examined. Students will identify and assess basic assumptions, fundamental research questions and opportunities, and limitations of these theories.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6714:

Organizational Behavior Theory Seminar

Foundational and contemporary paradigms and theories supporting organizational behavior and research are examined. How these paradigms and theories shape, constrain, and foster the development of research is explored. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6724:

Review of Strategic Management & Organizational Theory Research

Current research in strategic management and organizational theory will be examined. Students will assess fundamental research questions, opportunities, and limitations of this research. Current research methods in strategic management and organization theory will be discussed and examined. Pre-requisite: Graduate Standing

Credit Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6734:

Review of Research in Organizational Behavior & Human Resources Management

Current research in organizational behavior and human resource management will be examined. Students will assess fundamental research questions, opportunities, and limitations of this research.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6944:

Graduate Seminar in Management Research

Presentation and critical discussion of current literature and major topics in management research. The seminar provides a forum for the discussion of research and research problems in management and the presentation of research by graduate students. Provides students an opportunity to prepare and present current work related to their dissertation, and to engage in other activities related to the promotion of their professional development. Pre: Graduate standing.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MGT 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MARKETING

Paul Herr, Head

Professors: David Brinberg; Paul Herr; Kent Nakamoto; Julie Ozanne; Mack Sirgy;

Associate Professors: Rajesh Bagchi; Eloise Coupey;

Assistant Professors: Elise Ince; Yael Rugar; Kimberlee Weaver;

Visiting Faculty: Richard Buehrer;

R.B. Pamplin Professor of Marketing, Dept. Head, Associate Dean of

Research: Kent Nakamoto;

Robert O. Goodykoontz Professor of Marketing: David Brinberg;

Sonny Merryman Inc. Professor of Marketing: Julie Ozanne;

Professor of Real Estate: Mack Sirgy;

Virginia-Carolinas Professor of Purchasing Management: Paul Herr;

Graduate Programs Coordinator: jebanke@vt.edu

Graduate Site:

<http://www.marketing.pamplin.vt.edu/academics/graduate/index.html>

Doctoral Program in Marketing:

<http://www.marketing.pamplin.vt.edu/academics/graduate/phd.html>

The Department of Marketing participates in the Pamplin College of Business MBA programs and offers two focused programs - an M.S. program focused on marketing research and a PhD program focused on basic research in marketing. For students interested in careers in marketing management, information on the MBA program is available at <http://www.mba.vt.edu>. M.S. OverviewThe Marketing Department offers a focused Master of Science program with a concentration in advanced marketing research. The program serves students with two types of interests:1. Students who wish to pursue a Ph.D. but who have completed only an undergraduate degree. 2. Students with well defined interests in analytical positions in marketing research, advertising research, and marketing analytics. The program is highly selective and limited in size (admitting 1 to 3 students per year) and involves a high level of interaction with members of the marketing faculty. For students seeking to pursue a Ph.D., the M.S. program provides a point of entry for students with limited backgrounds, allowing them to gain insight on the training and career expectations for Ph.D.'s in marketing and to complete work preparatory to Ph.D. study in core areas like mathematics, statistics, and research methods. For students who choose to treat the M.S. degree as terminal, significant employment opportunities exist in marketing research and advertising research organizations as well as companies with strong business analytics groups. However, prospective applicants should understand that this program is not a substitute for the M.B.A. for students seeking a professional business degree. The M.S. program provides focused and

advanced technical training not available in the M.B.A. program of study and its requirements are quite different from the MBA. PhD OverviewThe Doctoral Program in Marketing is designed to develop graduates who assume positions as faculty members in research-oriented schools of business. The faculty has developed the doctoral program in marketing to provide challenging research and learning experiences for students seeking the skills to become leading researchers and communicators of advanced business knowledge. The key ingredients to the program's success are its excellent students and its dynamic, research-oriented faculty who publish regularly in the leading marketing journals. In addition, faculty members are active in national marketing associations such as the American Marketing Association, the Association for Consumer Research, INFORMS, and the Academy of Marketing Science. The program is highly selective, rigorous, and personalized. The size of the program is strictly controlled to allow for intensive faculty-student collaboration. The required coursework provides rigorous exposure to the academic research literature in marketing as well as research methods and statistics. At the same time, we recognize that students bring a variety of interests and we will work with students to develop programs of study that will allow them to productively pursue those interests.

SPECIAL FACILITIES

Center for Marketing and Consumer Health This research group in this center will apply marketing theories and methods to improve consumer health. Faculty in the center will examine a wide range of issues, particularly at the interface of consumer decision-making, technology, and public and social policy. The center will facilitate the coordination of joint research projects among the participating faculty and with other potential collaborators across other units on campus. **Forest Industries Center at Virginia Tech: A Sloan Foundation Industry Center**The Department of Marketing, which has assumed the leadership role for the Pamplin College's participation in this center, has been ranked in the nation's top 20 marketing departments in research productivity. Marketing faculty members have conducted numerous research projects to examine inefficiencies in the "seedlings-to-goods" supply chain and have published papers in the area of wood products.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

M.S. Degree Requirements The program of study includes a minimum of 30 credit hours of coursework at the graduate level, plus a comprehensive project, examination, or a thesis. The degree requirements include:- 9-12 credit hours of advanced marketing seminars (6000 level). - A minimum of 9 credit hours of research methods and statistics courses at the graduate level. Suggested courses include graduate study in statistics (STAT 5615, 5616, or 5004) econometrics (ECON 5125, 5126, 5127), Psychology (PSYC 5315, 5316), and/or Marketing (MKTG 6224). - 6-9 elective credit hours at the graduate level in a related discipline (e.g., psychology or economics) or graduate level business courses (if the student has the requisite background and space permits) that would contribute to the student's

ability to design and conduct sophisticated research. - A comprehensive applied project entailing the design and implementation of appropriate marketing research skills, an examination covering the marketing literature and research methods, or a master's thesis. Up to 6 credit hours will be awarded for the thesis. **PhD Degree Requirements**The program is designed as a four-year program with a strong research focus on behavioral marketing research areas including consumer research, consumer health and welfare, public policy, marketing strategy, and research methodology. The doctoral program, administered by the Graduate Program Committee in the Department of Marketing and the Graduate School of Virginia Tech, requires coursework in marketing content and theory, statistics, research methodology, and one supporting minor. The minor should be consistent with the student's interests and professional goals. Commonly selected minors include psychology, sociology, management, management science, and statistics. The program, in its entirety, is designed to train students to conceptualize, design and execute research; to analyze data; and to disseminate knowledge to peers, students, and practitioners.A series of marketing doctoral seminars are required during the first year of study. MKTG 6105, 6106, and 6304 focused on the marketing literature and current issues in academic research in the field. MKTG 6224 is oriented to research methods. Additional seminars may be offered for the benefit of doctoral students. In addition, at least two courses of graduate statistics must be taken beyond STAT 5615 and 5616 or equivalent, along with at least three courses in the chosen minor field. A major aspect of learning is the student-faculty relationship. This one-on-one interaction is emphasized early in the program through research assistantships and independent studies. As the student advances through the doctoral program, the focus of the program shifts from coursework to research activity. Following completion of the doctoral seminars in the first year, each student is required to take a qualifying examination building on the work completed to date. Students failing the qualifying examination will be asked to leave the doctoral program. In addition to study of the marketing literature, doctoral students are required to develop and present original research in seminar classes. Students will be expected to submit original research, some co-authored with members of the faculty, to major conferences and later to marketing journals. In addition to the departmental qualifying examination, students are required during their third year of study to develop a dissertation proposal and to defend it. This defense constitutes the University-required Preliminary Examination. The fourth year of the doctoral program is focused on pursuit of dissertation research. The final oral examination, including the defense of the dissertation, is administered after completion of the dissertation.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

M.S. Degree Requirements The program of study includes a minimum of 30 credit hours of coursework at the graduate level, plus a comprehensive project, examination, or a thesis. The degree requirements include:- 9-12 credit hours of advanced marketing seminars (6000 level). - A minimum of 9 credit hours of research methods and statistics courses at the graduate level. Suggested courses include graduate study in statistics (STAT 5615, 5616, or 5004) econometrics (ECON 5125, 5126, 5127), Psychology (PSYC 5315,

5316), and/or Marketing (MKTG 6224). - 6-9 elective credit hours at the graduate level in a related discipline (e.g., psychology or economics) or graduate level business courses (if the student has the requisite background and space permits) that would contribute to the student's ability to design and conduct sophisticated research. - A comprehensive applied project entailing the design and implementation of appropriate marketing research skills, an examination covering the marketing literature and research methods, or a master's thesis. Up to 6 credit hours will be awarded for the thesis. PhD Degree Requirements

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GRADUATE COURSES (MKTG)

MKTG 5104:

Marketing Policy And Strategy

Principles and processes of strategic marketing planning. Emphasis on development and implementation of marketing plans and programs.

Comprehensive case studies are used as the basis for analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ACIS 5104

Corequisite(s):

MKTG 5154:

Research for Marketing Decisions

The course encompasses: problem formulation, research design, data gathering instruments, scaling, sampling, data analysis for making marketing-related decisions, and solving marketing-oriented problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104

Corequisite(s):

MKTG 5254:

Product Strategy

Strategic product planning and new product development within the context of marketing. Topics include the role of the product manager, strategic marketing planning, product/market identification, new product development, and diffusion of innovations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104

Corequisite(s):

MKTG 5304:

Promotion Strategy

Emphasis on understanding and applying the principles of marketing communication from a managerial perspective. Course examines the marketing communication activities of an organization focusing on the economic, sociological, and psychological aspects of behavior.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104

Corequisite(s):

MKTG 5424:

Business Negotiation: Strategies, Tactics and Skills

Examines negotiating as a process where two or more parties seek to build upon their common interests and manage their divergent ones.

Both the context of negotiations and the skills of the parties in rational analysis and interpersonal relationships determine whether an agreement can be reached and the quality of the outcomes for the participants. Extensive use is made of simulated negotiation exercises followed by analysis of outcomes to enable students to practice applying concepts and theories developed by economists and social psychologists to concrete business cases. Pre-requisite: Graduate standing in the MBA program

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5444:

Marketing, Management and the Public Purpose

The social context of business, with particular attention to marketing practices and entrepreneurial ventures. Examination of the public policy issues that arise from the pursuit of capitalist enterprise as well as the role of marketing and entrepreneurship in advancing social welfare and economic development. Multi-disciplinary approach linking historical, socio-cultural, political/legal, ethical, and strategic analyses in a global context.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104, MGT 5314

Corequisite(s):

MKTG 5554:

Business Marketing Management

Business marketing is a course designed to familiarize the student with the environmental framework and major managerial problems in businesses marketing to other businesses, nonprofit organizations, governments, and those in other countries. It is also the purpose of this course to acquaint the student with the professional and operational literature of business marketing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104

Corequisite(s):

MKTG 5564:

Marketing of High Technology

This course covers the unique nature of demand for high tech products and applies the basic elements of marketing strategy--market segmentation and targeting, marketing mix elements--to the context of high technology. It also addresses the development of effective strategic, marketing plans for high technology goods and services. Pre: permission of instructor I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104

Corequisite(s):

MKTG 5604:

Marketing Principles

An introduction to marketing management for executive MBA students.

Considers the principles and processes of marketing planning in business and non-profit organizations. Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5614:

Marketing Analysis and Strategy

Study of methods for analyzing customers (particularly market segmentation), diagnosing competitive market structure, and forecasting demand and the use of this information to develop marketing strategy.

Executive MBA students only.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5624:

Business Negotiations

This course addresses the practice of successful negotiations in business, including the business activities of marketing, operations, finance, and information management. This course utilizes behavioral principles of negotiation to develop and refine students' understanding and practice of effective negotiating skills. Executive MBA students only.

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5634:

International Marketing Management

This course focuses on marketing decision making in a global context.

The course includes consideration of the impact of culture, politics, and economics and the resulting differences in marketing institutions, marketing decision making, and marketing strategy.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5604

Corequisite(s):

MKTG 5654:

Managing the Mktg Function

Concepts of marketing management in a global environment, including the role of marketing in business organizations, and the relationship of marketing to other organizational functions. Role of marketing for developing and sustaining a competitive advantage in the marketplace, based on effective managerial decision making. Covers new product development and branding, as well as the characteristics of effective target marketing. Emphasis on the role of developing appropriate business intelligence for strategic decision making. Pre-requisite:

Enrollment in the Executive MBA program

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5664:

Managing MKTG Relationships

Factors that influence development of professional relationships necessary to create long-term satisfaction and commitment to the firm and its services. Integrates research and best practices in professional services with concepts of relationship marketing to provide practical knowledge of how to develop the network of relationships, both internal (e.g., staff) and external (e.g., customers, suppliers, investors, media) needed to develop a sustainable supply of goods and services.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5654

Corequisite(s):

MKTG 5674:

Marketing in Dynamic Contexts

Strategic decision making to balance the interests of organizations (both profit and nonprofit) with those of society. Examination of public policy issues that arise from the pursuit of capitalist enterprise, as well as the role of marketing and entrepreneurship in advancing social welfare and economic development. Multi-disciplinary approach links historical, socio-cultural, political/legal, ethical, and strategic analyses in a global context.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5664 (UG)

Corequisite(s):

MKTG 5704:

International Marketing Strategy

This course provides the background to make managerial marketing decisions at the international level. It is composed of four sections: macro dimensions of international marketing, e.g., culture, politics, and economics; international comparative marketing systems; international marketing management decisions; and international strategic planning and control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5104

Corequisite(s):

MKTG 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MKTG 5954:**Study Abroad**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

MKTG 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MKTG 6105:**Advanced Topics In Marketing**

6105: Seminar in marketing theory, marketing research, buyer behavior, and marketing strategy. Emphasis on conceptual and methodological developments in marketing. 6106: Seminar in marketing management. Emphasis is placed on conceptual and methodological developments and quantitative decision models in promotion management, product and price management, channel of distribution management, and sales force management. May be repeated for credit up to 9 hours for each seminar with different content. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 6106:**Advanced Topics In Marketing**

6105: Seminar in marketing theory, marketing research, buyer behavior, and marketing strategy. Emphasis on conceptual and methodological developments in marketing. 6106: Seminar in marketing management. Emphasis is placed on conceptual and methodological developments and quantitative decision models in promotion management, product and price management, channel of distribution management, and sales force management. May be repeated for credit up to 9 hours for each seminar with different content. II. Permission of Instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 6105

Corequisite(s):

MKTG 6224:**Advanced Marketing Research**

Issues related to research design, measurement and scaling, and data collection procedures. Methods for doing integrative research reviews are also covered. Six hours of graduate statistics required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5154, MKTG 6214

Corequisite(s):

MKTG 6304:**Seminar in Buyer Behavior Research**

sociological, communication, and economic theories and research to the study of buyer behavior phenomena. Emphasis is placed on recent research findings and methodologies in buyer behavior.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5154

Corequisite(s):

MKTG 6404:

Advanced Quantitative Marketing Methods

Theory, method, and application of selected quantitative methods for marketing: linear structural relations, path analysis, canonical and discriminant analysis, and exploratory and confirmatory factor analysis. Special purpose methods such as conjoint analysis, multidimensional scaling, cluster analysis, and recent methodological developments also will be covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MKTG 5154

Corequisite(s):

MKTG 6444:

Seminar in Marketing & Society

The role of marketing in society from the standpoint of consumer welfare, including ethical considerations, economic analyses of consumer welfare, and social choice. Implications for transformative consumer research, social marketing, and public policy. Conceptual and methodological developments in academic research from marketing and related disciplines. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MKTG 7994:

Research and Dissert

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BIOMEDICAL ENGINEERING

Stefan Duma, Head

Hampton Gabler, Associate Head

Pamela VandeVord, Associate Head

Joel Stitzel, Associate Head

Emeriti Faculty: John Grant;

Professors: Anthony Atala; Khalil Bitar; John Bourland; David Carroll; George Christ; Thomas Diller; Stefan Duma; Michael Friedlander; Hampton Gabler; Harold Garner; Dwayne Godwin; Robert Gourdie; Paul Laurienti; Roop Mahajan; Joseph Maldjian; Pendleton Montague; Maury Nussbaum; Emmanuel Opara; John Robertson; Thomas Smith; Shay Soker; Joel Stitzel; William Wagner; James Yoo;

Associate Professors: Masoud Agah; Rafael Davalos; Raffaella De Vita; Aaron Goldstein; Craig Hamilton; Warren Hardy; Satoru Hayasaka; Yong Lee; Alexander Leonessa; Chang Lu; Michael Morykwas; Michael Munley; T Murali; Steven Poelzing; Padmavathy Rajagopalan; John Rossmesl; John Socha; Mark Stremler; Mark Van Dyke; Pamela VandeVord; Chris Wyatt; Yong Xu; Jianhua Xuan;

Assistant Professors: Bahareh Behkam; Lissett Bickford; Guohua Cao; Kerry Danelson; Francis Gayzik; Adam Hall; Benjamin Harrison; Youngkyoo Jung; Deborah Kelly; Brooks King-Casas; Robert Kraft; Stephen LaConte; Sang Lee; Sarah McDonald; Aaron Mohs; Alexei Morozov; Konark Mukherjee; Amrinder Nain; Alexander Powers; Anne Staples; William Tyler; Scott Verbridge; Thaddeus Wadas; Abby Whittington; Hengyong Yu; Yizheng Zhu;

Research Assistant Professors: Andrew Kemper; Steven Rowson;

Harry C. Wyatt Professor: Stefan Duma;

Research Associate Professors: Costin Untaroiu;

General Contact: tsentell@vt.edu

Department Web Site: <http://www.sbes.vt.edu/>

Admissions Information: <http://www.sbes.vt.edu/students/admissions.php>

Student Handbook: <http://www.sbes.vt.edu/academics/policies.php>

The Virginia Tech-Wake Forest University School of Biomedical Engineering & Sciences (SBES) is a multi-disciplinary, multi-institutional graduate program that bridges engineering, science and medicine. The

joint program combines the strengths and resources of Virginia Tech's College of Engineering, the Wake Forest University School of Medicine, and the Virginia-Maryland Regional College of Veterinary Medicine to produce an environment that fosters graduate education and outstanding interdisciplinary research. SBES diplomas carry the seals of both Virginia Tech and Wake Forest University. Graduate students choose a home campus (Blacksburg or Winston-Salem) based on their preferred areas of concentration within biomedical engineering, or their choice of faculty whose research interests them. However, they are able to experience the environments and faculty of both locations through courses taught by video-broadcast and through inter-campus visits and events. Currently SBES identifies seven general areas of concentrations referred to as "theme areas". They are: Biomechanics Tissue Engineering Biomedical Imaging Neuroengineering Nanomedicine & Nanobioengineering Translational Cancer Research Cardiovascular Engineering Students are encouraged to adhere to the theme area requirements specified by each faculty group; however, declaring a specific area is not required. The SBES encourages innovative thinking and novel approaches to problem-solving, therefore it attempts to tailor students' academic programs to assist them with their individual goals and research ambitions. Please refer to www.sbes.vt.edu for further details regarding concentration requirements. Currently the VT-WFU School of Biomedical Engineering and Sciences offers the following graduate degrees: Master of Science in Biomedical Engineering Doctor of Philosophy in Biomedical Engineering Two combined medical and engineering degrees described below.

SPECIAL FACILITIES

On the Blacksburg campus SBES occupies the new Institute for Critical Technology and Applied Science building on Stanger Street (ICTAS I) with approximately 30,000 sq. ft. of laboratory space designed specifically for cutting-edge biomedical research. Also available to graduate students at Blacksburg are the superior facilities of the Veterinary College (VMRCVM) which is part of the SBES alliance, the Virginia Bioinformatics Institute, located on the VT campus, and most recently the new Virginia Tech Carilion School of Medicine and Research Institute (VTCRI) located in Roanoke, VA. At Winston-Salem SBES students have access to top quality research resources through the Wake Forest University School of Medicine and its affiliation with North Carolina Baptist Hospital, one of the finest in the country. Additionally, SBES has ties to the Wake Forest Institute for Regenerative Medicine (WFIRM), an international leader in bringing cell and tissue engineering discoveries to clinical therapies. The WFIRM and other research groups are part of a 200-acre biotechnology initiative at the Piedmont Triad Research Park which will be the largest urban research park of its kind in the nation. SBES affiliated labs and research centers include:

Advanced Neuroscience Imaging Research Core (ANSIR) [Winston-Salem]

The Advanced Neuroscience Imaging Research (ANSIR) Laboratory is a research group based in the Department of Radiology of Wake Forest University School of Medicine. The lab is devoted to the application of novel image analysis methods (e.g. diffeomorphic registration, machine learning, graph theory, ASL) to research studies, as well as to robust clinical translation of these techniques. The lab also maintains a fully automated functional and structural image processing pipeline supporting the image storage and analysis needs of a variety of

scientists and imaging studies at Wake Forest. [Website Here](#)

Bio-imaging Systems Lab [Blacksburg]

The purpose of the Bio-imaging Systems Lab is to develop technologies to accelerate the use of imaging and image analysis in biomedicine. An important part of this goal is communicating with the clinical and basic scientists who benefit from our work. [website here](#)

Bioanatomic Imaging and Treatment Program [Winston-Salem]

The Bioanatomic Imaging and Treatment (BAIT) Program is a clinical and research program at North Carolina Baptist Hospitals and Wake Forest University School of Medicine. BAIT clinical and basic research focuses on the uses of bioanatomic imaging and treatment for patients who have cancer, on understanding the biological mechanisms of cancer as can be seen with imaging, and on radiation treatment responses. Our scientific programs include image-based clinical trials and basic research in imaging science and radiation treatment physics. [website here.](#)

Bioelectromechanical Systems Lab [Blacksburg]

Bioelectromechanical Systems is a cross disciplinary field that combines engineering and science from the nano to the macro level. In our laboratory we have developed technology for tissue viability detection, picoliter sample management, and imaging for molecular medicine. We have developed three inexpensive solutions that use electrical feedback to perform complex procedures in biotechnology with precision and control. Through this engineering approach, we have established robust methods for single cell analysis, selective cell concentration, and cancer therapy. [website here.](#)

Biomedical Imaging Division [Blacksburg and Winston-Salem]

The mission of the Biomedical Imaging Division is to define and advance biomedical imaging frontiers, optimize clinical / preclinical potentials, and train the next generation of imaging scientists and engineers.

Established in 2006 it consists of the bioluminescence tomography (BLT) laboratory, computed tomography (CT) laboratory, and the high-performance computer (HPC) laboratory. A balance is sought among theoretical studies, algorithm development, system prototyping, biomedical and other applications. [website here](#)

Biomedical Optical Devices (BODY) Lab [Blacksburg]

The BODY Lab focuses on translational research using optical diagnostic and therapeutic devices to solve unmet biomedical healthcare needs.

The broader impacts of this unique area of research will 1) improve quality of life for patients, 2) advance the frontiers of knowledge, and 3) educate the next generation of biomedical engineers. [website here.](#)

Center for Biomolecular Imaging [Winston-Salem]

The Center for Biomolecular Imaging (CBI) is a multi-technology Medical School facility comprised of state-of-the-art imaging modalities. Its purpose is to support imaging research while facilitating multidisciplinary research. Part of its mission is to change the imaging research paradigm from pathoanatomy to imaging opportunities related to physiologic/functional imaging and molecular imaging. [Website Here](#)

Center for Comparative Oncology (CeCO) [Blacksburg]

CeCO is an academic center for basic and clinical research on cancer. The Center is based at the Virginia-Maryland Regional College of Veterinary Medicine in Blacksburg, Virginia and unites a variety of cancer research programs on the Virginia Tech campus. The mission of CeCO is to study the development of cancer in animals and in people, to develop new ways to diagnose cancer, and to find new treatments to control and cure it. [website here](#).

Center for Injury Biomechanics [Blacksburg and Winston-Salem]

The Center for Injury Biomechanics performs research investigating human tolerance to impact loading. The application of this research includes automobile safety, military restraints, and sports biomechanics. The Center combines experimental testing with automobile test dummies and computational modeling in order to develop human impact injury criteria. [Website Here](#)

Center for Molecular Medicine and Infectious Diseases [Blacksburg]

The central theme of CMMID is "Animal Model of Diseases". Our faculty specialize in using various animal models that include not only traditional laboratory animal models (mice and rats), but also non-traditional (chickens, pigs, dogs, fish, crab, equine) animal models. Our mission is to employ animal models to better understand the disease processes that impact both humans and domesticated species. A sound basic understanding of pathogens will enable us to better design newer intervention strategies, such as genetically altered vaccines and immunomodulators. [Website Here](#)

Center for Nanotechnology and Molecular Materials [Winston-Salem]

Nanotechnology is engineering at the molecular level. At Wake Forest University's Nanotech Center the revolutionary principles of nanotechnology are being used to address the pressing needs of human society from health care to green energy technologies. The Nanotech Center is a shared resource serving academic, industrial, and governmental researchers across the region. We welcome researchers from any discipline who wish to explore uses of nano-materials and nanotechnologies in their work. [Website Here](#).

Center for Regenerative Medicine [VT-Carilion, Roanoke]

The research of the lab is on the subunit proteins of gap junctions -- connexins. Our work encompasses both basic and practical/translational aspects. In basic research we study cellular and molecular mechanisms of the carboxyl terminal domain of Cx43 in regulating gap junction remodeling and electrical conduction in the normal and arrhythmic heart. In our more practically oriented work, we focus on Cx43 assignments in wound healing, scarring, and regeneration. The lab is developing a platform of drugs targeting Cx43 function. [website here](#)

Comparative Biomechanics Lab [Blacksburg]

The main goal of the research in our lab is to understand how the mechanical properties of the structures used for animal movement, feeding, and reproduction arise from their component parts. We apply engineering techniques to an array of animals and behaviors to extract general rules regarding how body structure affects mechanical function in nature. Understanding the principles of biological material design across multiple levels of organization can provide insights into how these materials allow for and even enhance whole body performance. Such principles can then be used to inspire and improve the design of robots and medical prosthetics. [website here](#).

Comprehensive Cancer Center [Winston-Salem]

Because research brings hope, basic science, clinical and public health researchers at the Comprehensive Cancer Center of Wake Forest University collaborate to answer complex questions that lead to promising new treatments and therapies. The research programs are structured to optimize multidisciplinary and translational research. Our researchers work together to take the most promising discoveries from the laboratory into the clinic for the benefit of our patients and the cancer community as a whole. [Website here](#).

Computational Bioinformatics & Bio-imaging Laboratory [Northern Virginia]

We are electrical and computer engineering researchers by training who have developed a great interest in multiscale, computational, integrative, and system biomedical sciences, mainly inspired by our curiosity about the process of discovery. We enjoy close collaborations with biologists and physicians, and these partnerships provide us with the opportunities to learn new things, to ask new questions, and to pursue new discoveries. [Website Here](#)

Crash Injury Research & Engineering Network (CIREN) [Blacksburg and Winston-Salem]

The Crash Injury Research and Engineering Network (CIREN) is a multi-center research program involving a collaboration of clinicians and engineers in academia, industry, and government. Together, they are pursuing in-depth studies of crashes, injuries, and treatments to improve processes and outcomes. CIREN's mission is to improve the prevention, treatment, and rehabilitation of motor vehicle crash injuries to reduce deaths, disabilities, and human and economic costs. [Website here](#)

Human Neuroimaging Laboratory [VT-Carilion, Roanoke]

The Human Neuroimaging Laboratory (HNL) is part of the Virginia Tech Carilion Research Institute, located in Roanoke, Virginia. Research projects cover a wide variety of fields, including neuroscience, psychology, political science and economics. Particular areas of interest are hyperscanning (a means of exploring brain activity that underlies human social interactions), social neuroscience, neural circuitry of valuation and decision-making, and disruptions of such processes associated with developmental and psychiatric illness. The HNL serves as the primary imaging facility of the VTCRI. [Website here](#)

Industrial Ergonomics & Biomechanics Lab [Blacksburg]

The Industrial Ergonomics and Biomechanics Laboratory conducts work in theoretical and applied ergonomics, occupational biomechanics, and work physiology, primarily relating to work site, workstation, and equipment evaluation and design. Specifically, research is focused on biomechanics of the human body (modeling, strength, motions, and working postures); human engineering of systems, equipment, tools, workstations and work tasks, and ergonomic design for safety, efficiency, and performance. Website Here

Institute for Critical Technology and Applied Science (ICTAS) [Blacksburg]

The Institute for Critical Technology and Applied Science supports and promotes cutting edge research at the intersection of engineering, science and medicine. ICTAS stimulates, catalyzes, and promotes growth of research at Virginia Tech. ICTAS provides a collaborative atmosphere designed to stimulate and promote creativity, a place where intellectual capacity can be explored and challenged to reach areas previously explored in isolation. Website Here

Kelly Lab [VT-Carilion, Roanoke]

Research in the Kelly Lab at VTCRI focuses on developing innovative methodologies to study complex biological machinery. Combinations of structural and functional tools are used to understand how signaling pathways influence human development and disease. Cryo-Electron Microscopy (EM) allows us to peer into the world of cells and molecules around us. Affinity Capture technology is an innovative platform for visualizing molecules in action. We are developing this approach to transform our vision of the molecular world. Website here

Kevin P. Granata Biomechanics Lab [Blacksburg]

Our mission is to investigate the dynamics and neuromuscular control of human movement, and to train scientists to become leaders in the field of musculoskeletal biomechanics. The primary focus of research conducted in the MBL is injury prevention, with projects falling into two main categories: Balance and Fall Prevention, and Low-Back and Spine Biomechanics. Website Here

LaConte Lab [VT-Carilion, Roanoke]

Research in the LaConte Lab is devoted to advanced neuroimaging acquisition and data analysis approaches, aimed at understanding and rehabilitating neurological and psychiatric diseases. A major focus of the lab is an innovation in function magnetic resonance imaging (fMRI) which we developed and call "temporally adaptive brain state" (TABS) fMRI. The inception of TABS arose from two major recent advances in neuroimaging, namely 1) the recognition that multi-voxel patterns of fMRI data can be used to decode brain states and 2) the emergence of real-time fMRI as a viable tool for neurofeedback. website here.

Laboratory for Biomaterials and Tissue Engineering [Blacksburg]

Our research focuses on the development of model tissue constructs or functional tissue units and the study of cell-substratum interactions. A

primary goal is to design tissue constructs that mimic the native structure of tissues in-vivo and to systematically probe cellular response to a variety of cues. This involves the fabrication of bio-compatible scaffolds and templates, and more importantly tailoring surface and bulk properties. Another research interest of our group is to quantify cell-substratum interactions. Specifically, our studies focus on how chemical and mechanical properties of an underlying substratum affect cellular motility and contractility. Website Here

Laboratory for Complex Brain Networks [Winston-Salem]

The LCBN is a Wake Forest Baptist Health neuroscience and neuroimaging research facility located on the Medical Campus of Wake Forest University. It consists of an association of scientists located at universities, laboratories and research centers around the world that focus on imaging technology and emergence in complex systems. The primary focus of the laboratory is the development of innovative ideas, methods, and technologies for systematic understanding of emergence in dynamic complex systems such as the brain. Through the development and use of network science methods, the work of the LCBN offers a means to quantify and analyze networks of complex systems. Website here

Laboratory for Computational Biomechanics and Fluid Dynamics [Blacksburg]

The research at the Laboratory for Computational Biomechanics and Fluid Dynamics is focused on two main areas: computational models of physiological systems in the human body and computational fluid dynamics. A unifying theme is the use of multi-scale methods to create computational models and algorithms that exploit the inherent properties of systems to reduce the spatial and temporal complexity of a given problem. website here.

Laboratory of Vascular Biology [Blacksburg]

There are three main focus areas involved in the research efforts of the vascular biology lab: a) Pro-oxidative and pro-inflammatory mechanisms of human chronic vascular disease, such as stroke, atherosclerosis, Alzheimer's disease, and tumor angiogenesis/metastasis. b) Biomedical applications of nanotechnology: novel therapeutic explorations for brain injury and cancer progression by vascular endothelial cell targeting of bioconjugated nanoparticles. c) Cellular and molecular signaling mechanisms of the vascular responses to shear stress. Website Here

Locomotion Research Lab [Blacksburg]

The Locomotion Research Lab conducts research directed toward discovering ways to prevent falls among the elderly by investigating the relationship between aging and falling. Volunteer subjects are placed in a harness fitted with a network of sensors that test musculoskeletal and neuromuscular changes and biomechanical responses during slips and recoveries. They walk on an experimental platform where they are induced to slip and execute a recovery (an actual fall is prevented by the harness). All the data from the monitoring sensors is fed into a computer

model, providing information about the subject's gait while walking and the motions involved in slipping and recovery. Knowledge gained will contribute to the the reduction in numbers of deaths due to falls in the elderly -- numbers which have risen from 14,900 in the year 2000 to 17,700 in 2005. [Website Here](#)

Mechanics of Soft Biological Systems Lab [Blacksburg]:

The Mechanics of Soft Biological Systems Laboratory focuses on characterizing the mechanical properties of biological structures ranging from lipid bilayers to collagenous tissues in vertebrates and chitin-based tissues in invertebrates. The common theme of the lab is the study of the relationship between complex structures and mechanical behavior of biological system, using approaches that combine physically-sound theoretical models with novel experimental methods. [website here.](#)

Micro/NanoScale Biotic/Abiotic Systems Engineering (MicroNBASE) Laboratory [Blacksburg]

Our lab focuses on interfaces between biological and synthetic systems (or bio-hybrid-engineering). The research interests cover the study of micro-nano-robotics, nanotechnology, bio-nano interface, and biophysics of bacteria motility, chemotaxis and adhesion. There are two main broad categories of activities: (1) developing bio-hybrid engineered systems (biomicrobots) in which biological components are utilized for actuation, sensing, communication, and control. (2) studying mechanisms of adhesion, motility and sensing in cells or unicellular microorganisms. [website here](#)

Microfluidics Lab [Blacksburg]

Our research is concerned with the new science and technology generated by applying micro/nanofabricated structures and devices to biological studies and biosensors. One emphasis in our research is to develop high-throughput microfluidic tools to manipulate and analyze single cells and extract biological information. Another thrust in the group is on developing flow-through electroporation for efficient gene delivery into cells. Our ultimate goal is to apply this technique to create genetically modified cells for cancer immunotherapy, stem cell therapy and tissue regeneration. [website here.](#)

Mohs Biomedical Imaging and Nanotechnology Group [Winston-Salem]

Our primary research focus is on the development of novel imaging contrast agents and optical instrumentation for the image-guided surgical removal of tumors. Improved detection of tumors intra-operatively may decrease the recurrence rate of certain kinds of tumors after surgery. We are also interested in the emerging field of "Regenerative Imaging". We are initializing projects that utilize molecular imaging to (1) understand the fundamental principles of tissue regeneration and (2) establish translational imaging techniques to evaluate tissue regeneration in a clinical setting. [Website here.](#)

Nanostructured Biopolymer Engineering Lab [Blacksburg]

Biomaterials are an essential tool that provides the basis for

bioengineered devices, growing and delivering cells, developing functional tissues, and engineering whole organs. Natural biopolymers that self-assemble on the nano scale have the potential to provide native cellular environments that facilitate the directed behavior of cells. Research conducted by the Nanostructured Biopolymer Engineering Lab makes use of naturally derived structural proteins for biomaterials development. Using primarily keratin proteins, Dr. Van Dyke's research group creates matrices and scaffolds used for tissue engineering and trauma applications, and studies their fundamental characteristics such as molecular self-assembly and structure-function relationships.

Quantitative Imaging Lab [Winston-Salem]

The focus of the Magnetic Resonance Quantitative Imaging Lab is to develop quantitative imaging techniques with magnetic resonance imaging to answer scientific questions and improve patient care. These imaging techniques are being used in numerous collaborative projects ranging from temperature mapping to evaluate new hyperthermia treatments with multiwalled carbon nanotubes, to measuring cerebral blood flow for improving patient care, to using phase contrast imaging to measure vascular stiffness. Traditional medical imaging has largely been qualitative, that is, the intensity of a pixel is arbitrary and only conveys relative information when comparing pixels. In contrast, the pixel intensities in quantitative images are directly proportional to a physical parameter (temperature, density, blood flow, velocity, concentration, etc.). This type of imaging provides repeatable, observer-independent measure of physical quantities.

Socha Lab: Comparative Biomechanics & Bio-Inspired Engineering [Blacksburg]

Our lab studies the biomechanics of motion in animals, conducting integrative research that crosses traditional boundaries of engineering and biology. Currently, two broad themes of our research center around gliding flight in vertebrates and internal fluid flows in invertebrates. We aim to understand animal movements both for fundamental understanding of animal physiology, ecology and evolution, and as inspiration for novel engineering applications. [website here.](#)

Soft Mechanical Structures Laboratory [Blacksburg]

The mechanics of soft structures provide a great framework to study problems ranging from flexible devices to biological interfaces. The ability for these structures to accommodate large stresses and deformations via dramatic elastic instabilities aid in the design of advanced, responsive material. Our group is interested in using elasticity, soft materials, and instabilities such as snap-buckling, crumpling, wrinkling, and folding to study the fundamental mechanics of soft or slender structures. Using this knowledge we will generate structural responsiveness and impact properties such as adhesion, optics, and flow at surfaces or within devices. [Website here](#)

T. M. Murali Laboratory [Blacksburg]

The functioning of a living cell is governed by intricate networks of

physical, functional, and regulatory interactions among different types of molecules. Recent experimental advances have yielded unprecedented insights into the structure of these interaction networks and into patterns of molecular activity (mRNA, proteins, and metabolites) in response to different conditions. The ultimate goal of my research is to build phenomenological and predictive models of these networks by developing approaches that investigate the relationships among the molecules in a cell, how these elements are organized into functional modules, how these modules interact with each other, and how different modules become activated or de-activated in various cell states.

Website here.

Tissue Engineering Lab [Blacksburg]

The Tissue Engineering Laboratory explores methods for developing engineered bone and ligament tissues using a combination of novel biomaterials, adult stem cells, and advanced bioreactor technologies. Some specific issues being addressed include; elastomeric polyurethane biomaterials, electrospun fiber meshes with tunable mechanical and topographical properties, mechanotransduction and cell signaling in dynamic bioreactors, quantitative imaging of developing tissues, and fluid mechanics and mass transport. Website Here

Tissue Engineering, Nanotechnology, and Cancer Research (TENCR) Lab [Blacksburg]

The Tissue Engineering, Nanotechnology, and Cancer Research Lab conducts research in many diverse areas including; 1) development and multimodal cancer therapies using novel nanomaterials, 2) measurement and modeling of biotransport and tumor response to therapy, 3) creation of systems for real time monitoring and control of dynamic biological processes, 4) stress conditioning strategies for tissue regeneration, and 5) creation and utilization of tumor representative systems for therapy development. Website here.

Translational Oncology & Nano/Pharmacoengineering Laboratory [Blacksburg]

The Translational Oncology and Nano/Pharmacoengineering Lab works in a highly multi-disciplinary environment to solve problems in cancer diagnosis and treatment through the combination of existing and emerging technologies. In our laboratory, we are interested in developing needle-based medical devices for cancer detection and treatment in real time. We are also interested in developing sustainable non-toxic nanopharmaceuticals that are designed and validated to be safe in the environment and in humans. Website here

Tyler Neuroscience & Neurotechnology Laboratory [VT-Carilion, Roanoke]

The Tyler Neuroscience & Neurotechnology Laboratory focuses its research efforts on the fundamental properties of synaptic transmission, how these properties are modified by experience, and how best to control neuronal activity for making nervous systems more efficient. One primary goal is to develop novel methods for the control of neuronal

activity in intact brain circuits by means of engineering methods, devices, and applications for the use of pulsed ultrasound in the noninvasive remote control of brain activity. Work is also being done to develop a better understanding of the manner by which natural activity patterns modify the strengths of sensory inputs. Website Here.

VT MEMS Laboratory [Blacksburg]

Research at VT MEMS Lab currently centers on the development of three-dimensional micromachining techniques, micro gas analyzers for environmental and healthcare applications, biochips for cell analysis, cancer diagnosis, and cancer treatment monitoring, and biochips for pathogen detection in water. MEMS technology is used along with various microscopy techniques to determine mechanical and electrical signatures of cells under controlled microenvironments. Additional major thrust areas of research include micro analytical chemistry and micro/nano fabrication. Website here

Verbridge Lab: Engineering the Tumor Microenvironment [Blacksburg]

The Verbridge lab's main thrust is in using the tools of micro/nano technology and tissue engineering to study the role of cell-microenvironment interactions in cancer. One aim is to develop new engineering tools and in-vitro culture platforms to illuminate cellular response to microenvironmental cues (i.e. cell-cell, cell-matrix, chemical, electrical) and stresses (i.e. hypoxia, radiation, drug treatment) in a physiologically relevant 3-D context. website here.

Vestibular Mechanics Laboratory [Blacksburg]

Our lab investigates the mechanics behind the stimulus of hair bundles in the utricle through experiments and finite element modeling. The utricle, an organ in the inner ear that contributes to one's sense of balance, responds to changes in acceleration by a shearing of hair bundles contained within the layers of the utricle otoconial membrane (OM). Through experiments on and finite element models of both hair bundles and utricle OMs, we can discover how hair bundles are stimulated in-vivo and how mechanics of the utricle OM and the hair bundles can affect one's sense of balance.

Virginia Bioinformatics Institute (VBI) [Blacksburg]

VBI is a world-class research institute dedicated to the study of the biological sciences. by using bioinformatics and medical informatics, which combines transdisciplinary approaches to information technology and biomedicine, researchers at VBI create, interpret, and apply vast amounts of biological data generated from basic research to some of today's key challenges in the biomedical, environmental and agricultural sciences. The institute develops genomic, proteomic, and bioinformatic tools and databases to study genomes and diseases for the discovery of new vaccine, drug and diagnostic targets for humans and the species upon which they depend to improve our quality of life, health and security. website here

Virginia Tech - Carilion Research Institute (VTCRI) [Roanoke]

Located in Roanoke, VA the VTCRI provides state-of-the-art facilities for molecular medicine, imaging using lasers, high-power electron beams and magnetic resonance, high capacity data handling, and human performance analysis. It is also the hub for the world-wide hyperscanning network for interactive functional brain imaging. [website here.](#)

WFSM Orthopedic Surgery Lab [Winston-Salem]

Orthopedic Surgery has numerous collaborative research projects with SBES faculty in many areas including: Hand/Upper Extremity/Microsurgery Sports Medicine Orthopedic Trauma and Foot & Ankle Surgery Total Joint Arthroplasty, Adult Reconstruction and Joint Preservation Surgery (Hip and Knee)

Wake Forest Institute for Regenerative Medicine (WFIRM) [Winston-Salem]

Ever since the first engineered skin tissue was transplanted in 1981, the potential of regenerative medicine has captured the imagination of physicians and scientists worldwide. Technologies for engineering tissues are developing rapidly, with the ultimate goal of delivering new therapies into patients as safely and efficiently as possible. Our current research focuses on a wide range of engineered tissues with the aim of making a lasting impact on conditions ranging from diabetes to heart disease. In addition, we're working to apply the science of regenerative medicine to battlefield injuries and are working to help solve the shortage of donated organs available for transplant. As a result of our preliminary successes, tissue engineering and cellular therapy programs now span multiple organ systems. [Website Here](#)

X-Ray Systems Lab [Blacksburg]

The X-ray Systems Lab aims at developing novel medical imaging technologies for biomedical and bioscientific discovery, radiological diagnosis, and medical intervention. Directed by Dr. Guohua Cao, the lab focuses on novel x-ray sources, detectors, and system engineering. Our research activities are interdisciplinary and translational, and interface between basic sciences, translational development, and clinical applications. [website here.](#)

DEGREES OFFERED

PhD Degree

Offered In (Wake Forest, Blacksburg)

GRE

General Test: Verbal, Quantitative, Analytical Writing (4.0)

GRE COMBINED (V & Q): Minimum "Old" Combined score (1200.0), Minimum "New" Combined score (310.0)

TOEFL

Paper: (600.0)

iBT: (100.0)

IELTS

IELTS: Band: (7.0)

The Ph.D. degree requires a minimum of 90 total credit hours beyond the baccalaureate. Additionally, a dissertation must be written and defended before a 5-person committee. The Ph.D. plan of study is due by the end of the third semester of study registered as a Ph.D. student. All coursework must be 5000-level and above (VT campus) and 600-level and above (WFU campus). The distribution of required hours can be: 40 - 55 credit hours of research (7994-level only, VT) 35 - 50 course credits Specific course of study requirements are as follows: Course Requirements for BME Ph.D. Program: The Doctor of Philosophy degree in Biomedical Engineering must include the following minimum requirements: 15 credits of engineering courses (BMES or from any engineering department) to include the required courses, Quantitative Cell Physiology and Quantitative Organ Systems Physiology. 6 credits of graduate level mathematics, only 3 of which may be in statistics (see approved lists on website for each campus location) 3 credits of life science coursework from approved courses and/or departments on each campus (see website/handbook for details) 2 credits from the required BMES 6064 Clinical Rotation (available only to PhD candidates) 9-24 credits in elective coursework, remainder of hours up to 90 in research Ph.D. students must complete a required Medical Ethics module which, even though it carries 0 credits (is not a "course"), must be listed on the plan of study. They are also required to enroll in and successfully complete the SBES Seminar course (BMES 5944 at VT and BMES 694 at WFU) each semester of the academic year during their degree program. Ph.D. students must pass a Qualifying Exam no later than the end of the second year for students entering directly into the Ph.D. program or within one year of entering the program after completing the M.S. degree. ALL students are expected to participate in the annual Research Symposium held each spring, and are required to do an oral research presentation at least once before they graduate. Ph.D. students may elect to earn an M.S. degree "along-the-way" to the Ph.D. with the prior approval of their advisor. They must file an M.S. plan of study at the end of the second semester of study just as the regular M.S. students do, and they will write and defend a thesis. Please refer to www.sbes.vt.edu for details regarding all degree requirements.

Degree Concentrations:

Biomechanics

The following list represents some of the specific research topics offered by the Biomechanics faculty of SBES: Impact injury biomechanics Sports and military biomechanics Cell and tissue injury biomechanics Fluid flow dynamics Musculoskeletal biomechanics: gait, locomotion, spinal stability, falls, effects of aging Molecular and cellular biomechanics Ergonomics and work physiology: occupational biomechanics Computational modeling in biomechanics Organismal biomechanics Biomechanics: animal locomotor systems Vestibular mechanics Soft tissue biomechanics Micro and macro mechanisms of trauma

Tissue Engineering

The following list represents some of the specific research topics offered by the Tissue Engineering faculty of SBES: Regenerative medicine Tumor engineering platforms Biomaterials Musculoskeletal tissue regeneration Vascular regeneration Tissue engineering and clinical translation Liver tissue engineering Stem cells for tissue engineering Development of engineered tissues and organs Biomedical applications of nanotechnology Biological response of tissue engineered scaffolds:

in-vitro & in-vivo Techniques and devices for modifying tissue optical properties Biomaterials for targeted drug delivery

Biomedical Imaging

The following list represents some of the specific research topics offered by the Biomedical Imaging faculty of SBES: Medical physics Magnetic resonance imaging (MRI) and functional MRI (fMRI) X-ray computed tomography Bioluminescence and fluorescence imaging Image guided therapy / image guided surgery Biophotonics and biomedical optics Multimodality imaging applications Quantitative imaging techniques Medical imaging software development Biomedical image & signal processing Optical coherence tomography Radiation response modeling Optical molecular imaging for early cancer development Modification of tissue optical properties

Nanomedicine and Nanobioengineering

The following list represents some of the specific research topics offered by the Nanomedicine and Nanobioengineering faculty of SBES: Bio-MEMs and microfluidics Biotransport Biomembranes Biophysics Cellular Dynamics Cell and tumor microenvironments Biomedical applications of nanotechnology Nano-photonics Nanosized contrast agents for non-invasive imaging Biomedical microdevices Growth & assembly of novel nanostructures Nanotechnology for therapeutics and diagnostics

Neuroengineering

The following list represents some of the specific research topics offered by the Neuroengineering faculty of SBES: Neuroimaging Traumatic brain injury Neural network behavior Neurotrauma and nerve regeneration Neuroengineering Fundamental properties of synaptic transmission Neuralfeedback Experimental and computational investigation of neural control Machine learning Development of novel MRI techniques to map brain function Role of synaptic signaling in neuro-development

Translational Cancer Research

The following list represents some of the specific research topics offered by the Translational Cancer Research faculty of SBES: Targeted drug delivery Irreversible electroporation Molecular medicine / molecular imaging Cancer detection and treatment Cellular and molecular mechanisms of human disease Comparative oncology of malignant melanoma Minimally invasive surgery Vascular biology and tumor angiogenesis Using nanomaterials in cancer detection and therapy Dielectrophoretic cell manipulation Cancer cell evolution Thermal therapy design for cancer treatment

Cardiovascular Engineering

The following list represents some of the specific topics offered by the Cardiovascular Engineering faculty of SBES: Cardiovascular fluid mechanics and transport Arterial and coronary disease Left ventricular hemodynamics and heart failure Cellular and molecular mechanisms of connexins Gap junction remodeling in the normal and arrhythmic heart Cx43 assignments in wound healing, scarring, and regeneration Drug development targeting Cx43 function Cardiac electrophysiology and ion

transport Cardiac arrhythmia mechanisms Non-traditional bioelectric mapping

MS Degree

Offered In (Wake Forest, Blacksburg)

GRE

General Test: Verbal:, Quantitative:, Analytical Writing: (4.0)

Combined Score (V & Q): "Old" Combined score (1200.0), "New"

Combined score (310.0)

TOEFL

Paper: (600.0)

iBT: (100.0)

IELTS

IELTS: Band: (7.0)

The Master of Science degree requires a minimum of 30 total credit hours beyond the baccalaureate which must consist of: 6 - 9 credit hours of research (5994-level only, VT) 21 - 24 course credits Specific course of study requirements are as follows: Course Requirements for BME M.S. Program: The M.S. degree in Biomedical Engineering must include the following minimum requirements: 9 credits of engineering courses (BMES or from any engineering department) to include the required courses, Quantitative Cell Physiology and Quantitative Organ Systems Physiology. 3 credits of graduate level mathematics which can be either pure math or statistics from approved lists on each campus (see website) 3 credits of life science from approved courses and/or departments on both campuses (see website/handbook for details) 6 - 9 credits in elective courses, the remainder up to 30 in research All coursework must be at the 5000-level or higher (Blacksburg) and 600-level or higher (Wake Forest). M.S. students must also enroll in and successfully complete the SBES Seminar course (BMES 5944 at VT and BMES 694 at WFU) each semester of the academic year during their degree program. A written plan of study is to be submitted at the end of two semesters of graduate study. All M.S. students write and defend a thesis. There is no non-thesis M.S. degree in SBES.

Degree Concentrations:

Biomechanics

The following list represents some of the research topics offered by the Biomechanics faculty of SBES: Impact injury biomechanics Sports and military biomechanics Cell & tissue injury biomechanics Cardiovascular biomechanics Fluid flow dynamics Musculoskeletal biomechanics: gait, locomotion, spinal stability, falls, effects of aging Molecular & cellular biomechanics Ergonomics & work physiology; occupational biomechanics Computational modeling in biomechanics Organizational biomechanics Biomechanics: animal locomotor systems Vestibular mechanics Micro and macro mechanisms of trauma

Tissue Engineering

The following list represents some of the specific research topics offered by the SBES Tissue Engineering faculty: Regenerative medicine Tumor engineering platforms Biomaterials Musculoskeletal tissue engineering Vascular regeneration Tissue engineering and clinical translation Liver

tissue engineering Stem cells for tissue engineering Development of engineered tissues and organs Biological response of tissue engineered scaffolds: in-vitro and in-vivo Techniques and devices for modifying tissue optical properties Biomaterials for targeted drug delivery

Biomedical Imaging

The following list represents some of the specific research topics offered by the SBES Biomedical Imaging faculty: Medical physics Magnetic resonance imaging (MRI) and functional MRI (fMRI) X-ray computed tomography Bioluminescence and fluorescence imaging Image guided therapy / image guided surgery Biophotonics and biomedical optics Multimodality imaging applications Quantitative imaging techniques Medical imaging software development Medical image & signal processing Optical coherence tomography Radiation response modeling Optical molecular imaging for early cancer detection Modification and tissue optical properties

Nanomedicine and Nanobioengineering

The following list represents some of the specific research topics offered by the SBES Nanomedicine and Nanobioengineering faculty: Bio-MEMS and microfluidics Biomembranes Biotransport Biophysics Cellular dynamics Cell and tumor microenvironments Biomedical applications of nanotechnology Nano-photonics Nanosized contrast agents for non-invasive imaging Biomedical microdevices Growth & assembly of novel nanostructures Nanotechnology for therapeutics and diagnostics

Neuroengineering

The following list represents some of the specific research topics offered by the SBES Neuroengineering faculty: Neuroimaging Traumatic brain injury Neural network behavior Neurotrauma and nerve regeneration Neuroengineering Fundamental properties of synaptic transmission Neural feedback Experimental and computational investigation of neural control Machine learning Development of novel MRI techniques to map brain function Role of synaptic signaling in neuro-development

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Cardiovascular Engineering

The following list represents some of the specific research topics offered by the SBES Cardiovascular Engineering faculty: Cardiovascular fluid mechanics and transport Arterial and coronary disease Left ventricular hemodynamics and heart failure Cardiovascular devices and implants Cellular and molecular mechanisms of connexins Gap junction

remodeling in the normal and arrhythmic heart Cx43 assignments in wound healing, scarring, and regeneration Drug development targeting Cx43 function Cardiac electrophysiology and ion transport Cardiac arrhythmia mechanisms Non-traditional bioelectric mapping

GRADUATE COURSES (BMES)

BMES 5004:

Mammalian Physiology

Cell biology, neurological and muscle physiology, autonomic nervous system, cardiovascular system, cardiac function & hormonal regulation, pulmonary system, renal system, endocrinology, gastrointestinal system, glucose and lipid storage for biomedical engineering students only.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5014:

Quantitative Physiology

Mathematical modeling, simulation, quantitative description of organ physiology and control. Numerical simulation of physiologic processes. Cell resting membrane potential, and nerve and muscle tissue. Regulation of cardiac output, venous return, and closed-loop control. Pressure-volume behavior of alveoli and respiratory ventilation control. Nephron countercurrent mechanism, and hemodialysis. Metabolism, internal heat generation and temperature regulation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMES 5004, MATH 5495 OR ESM 5725

Corequisite(s):

BMES 5024 (BMVS 5224):

Biomedical Engineering and Human Disease

Comprehensive overview of a variety of human diseases, including, neurological disorders, cardiovascular disease, infectious disease, and cancer, designed primarily for graduate students majoring in engineering and other related areas who have a long-term academic and professional goal in the field of biomedical engineering and life sciences. Introduction to state-of-the-art biomedical engineering approaches used for the study of early detection/diagnosis, treatment and prevention of human disease. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMES 5004 OR BMVS 4064

Corequisite(s):

BMES 5044 (BSE 5044) (CHE 5044):

Engineering Mathematics

Introduction to numerical solutions of partial differential equations using the finite element method in one-, two-, and three-dimensions with direct relevance to chemical engineering, biological systems engineering and biomedical engineering and sciences. Partial differential equations and ordinary differential equations using finite differences, model parameter sensitivity analysis, optimization, and data analysis. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5054:

Quantitative Cell Physiology

Mathematical modeling, simulation, quantitative description of cell physiology and control. Numerical simulation of cellular physiologic processes including reaction kinetics, inhibition and cooperativity, passive transport, facilitated and carrier-mediate reaction kinetics. Cell resting membrane potential, and nerve and muscle tissue. Modeling of neural cell processes including voltage-gated channels, neurotransmitter kinetics, and postsynaptic cell membrane potentials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): BMES 5044

BMES 5064:

Quantitative Organ Systems Physiology

Mathematical modeling, simulation, quantitative description of organ physiology and control. Numerical simulation of cardiovascular physiologic processes including regulation of cardiac output, the baroreceptor - stroke volume model, venous return, and closed-loop control. Respiratory ventilation mechanics, gas exchange, pulmonary circulation, alveolar-capillary diffusion, and respiratory ventilation control.

Nephron countercurrent mechanism and hemodialysis. Modeling of endocrine system functions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): BMES 5044

BMES 5124 (ESM 5224):

Advanced 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5134:

Biomech & Sim Movement I

Key topics in movement biomechanics, including muscle physiology and mechanics, neural control, kinematic and dynamic modeling, and dynamic simulation. Discussion of real-life application in medicine and sports, and practical experience using engineering equipment (motion capture and EMG) and software used in research and industry to analyze human movement. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5144:

Biomechanics & Simulation of Movement II

Advanced topics in movement biomechanics and computational analyses of human movement, including advanced muscle modeling, motor control theories, dynamic simulation and optimization, and neural interfaces. Discussion of fundamental research underpinnings and clinical applications. Practical simulation labs and project-based exploration of dynamic and analyses. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5164 (ME 5754):

Advanced Impact Biomechanics

A review of impact biomechanics and critical investigation of the impact response of the human body. Participants will study the dynamic response of the head, neck, chest, abdomen, upper extremities, and lower extremities. Real world examples from automobile safety, military applications, and sport biomechanics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ME 3504 (UG), ME 3614 (UG)) OR (ESM 3054 (UG), ESM 3124 (UG)) OR (ME 3504, ME 3614) OR (ESM 3054, ESM 3124)

Corequisite(s):

BMES 5174 (ME 5174):

Biomechanics of Crash Injury Prevention

Principles of design and analysis of crash injury prevention methods in vehicle crashes. The course encompasses three major focus areas for occupant protection in crashes: crash energy absorption in (1) the vehicle structure, (2) the occupant, and (3) the occupant restraints. Topics include the biomechanics of impact injury, analysis of occupant response in crash tests, vehicle crash kinematics, modeling of vehicle impact response, modeling of human impact response, and occupant restraint design. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5184:

Injury Physiology

Introduction to the physiology of injury. Focus on the pathophysiology, mechanisms, and outcomes of injury in humans. Explores injury physiology at the organ, tissue, and cellular level. Topics include physiology of injury to the peripheral and central nervous systems, the musculoskeletal system, the pulmonary system, the abdomen, and the eye. Includes the injury physiology of adults as well as the special populations of children, pregnant females, and the elderly. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMES 5004

Corequisite(s): BMES 5164

BMES 5214 (ISE 5614):

Human Physical Capabilities

Focuses on the modeling, analysis, and evaluation of industrial workplaces with emphasis on the physical demands placed on and the capabilities of workers. Topics covered include: physiology, anthropometry, bioinstrumentation, and biomechanics. Students will learn and apply a range of contemporary analytical and assessment methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5244:

Biofluids

Fluid dynamics of physiological systems with focus on the cardiovascular and the respiratory systems. The course will address: the heart, arterial blood vessels, airways; description of cardiac and pulmonary circulation; anatomy and function of the heart; anatomy and function of the respiratory system; mechanics of soft tissues; review of basic fluid mechanics; continuum mechanics and constitutive modeling; rheology of blood, Newtonian and non-Newtonian; Viscous flow in vessels, Navier-Stokes; mathematical analysis of pulsatile flow; pulse-wave propagation through vessels; particulate flows and particle transport in airways. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ME 3404 (UG) OR ME 3404) OR (ESM 3015 (UG) OR ESM 3015)

Corequisite(s):

BMES 5304 (CHE 5304):

Biological Transport Phenomena

The fundamental principles of mass transport phenomena will be introduced and applied to the characterization of transport behavior in biological systems (e.g., cell, tissues, organs, people). Topics will include

active, passive, and convective molecular transport mechanisms. These fundamentals will be used to develop analytical and predictive models that describe phenomena such as oxygen transport, kidney function, systemic drug delivery, and design of extracorporeal devices. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHE 3114 (UG) OR CHE 3114, (CHE 3044 (UG) OR CHE 3044 OR CHE 3144 (UG) OR CHE 3144) OR (ME 3304 (UG) OR ME 3304, ME 3404 (UG) OR ME 3404)

Corequisite(s):

BMES 5314:

Introduction to Regenerative Medicine

Current state of the field of regenerative medicine with specific emphasis on the technological challenges that limit the efficacy and clinical translation of engineered tissues and therapies. Life science (e.g., cell biology, organ physiology, biochemical methods) and engineering perspectives (e.g., stem cells, biologically-inspired materials, gene therapies) Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5334:

Cell Adhesion

Study of the mechanisms of cell-cell and cell-surface attachment, corresponding models to describe the kinetics of attachment and binding, and testing methods to assess the strength of cellular adhesion. The course includes the contributions of surface chemistry and morphology, receptor biology, and a series of modules showing the biophysics of cell adhesion in real systems. Graduate standing in Biomedical Engineering or other relevant disciplines in the biological sciences.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5344:

Skin: Properties, Function, and Bioengineering Applications

Study of the physical, mechanical, thermal, and diffusive properties of skin using engineering principles. The relationship to diseases and damage as manifested in terms of differences in these properties is covered. Included among topics are age-related compositional changes, wounds and wound healing as well as using skin as an overall gauge of health. Graduate Standing in Biomedical Engineering or other relevant disciplines in the biological sciences.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5424:

Fundamentals of Tissue Structure, Function, and Replacement

Descriptions of the structures of tissues such as skin, bone, ligament, cartilage and blood vessels. Relationships between the structures of these tissues and their functions. Descriptions of the components of these tissues and their mechanical properties. Introduction to tissue mechanics and mathematical modeling of tissue behavior. Introduction to mechanical testing methods of hard and soft tissues. Methods for tissue replacement. Graduate standing required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMES 5004 (UG) OR BMES 5004

Corequisite(s):

BMES 5434 (CHE 5214):

Polymeric Biomaterials

Topics include polymer design and processing, inflammatory responses to polymers, interaction of blood with polymeric materials, and the effect of mechanical, chemical, and surface properties of polymers on cells. The culmination of this course will provide students with the knowledge to successfully design polymer-based biomaterials, drug-delivery devices, and bio-implants. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Digital Signal Processing for Mechanical Measurements

The fundamentals of digital signal processing of data experimentally obtained from mechanical systems will be covered. Attention will be given to the data acquisition, A/D conversion, aliasing, anti-aliasing filtering, sampling rates, valid frequency ranges, windowing functions, leakage, and various transform methods. Special attention will be given to random, transient, and harmonic function data processing. Various methods of estimation of the frequency response function (FRF) will be explored. The estimation methods will be assessed as to their impact on FRF estimation errors.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5525 (ECE 5605):

Stochastic Signals and Systems

Engineering applications of probability theory, random variables and random processes. Time and frequency response of linear systems to random inputs using both classical transform and modern state space techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

BMES 5526:

Stochastic Signals and Systems

Engineering applications of probability theory, random variables and random processes. Time and frequency response of linear systems to random inputs using both classical transform and modern state space techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BMES 5525 (UG) OR BMES 5525

Corequisite(s):

BMES 5554:

Biomedical Signal and Image Processing

The mathematical theory underlying the processing of one and two dimensional signals, including Fourier transforms, sampling,

quantization, correlation, and filtering. For images, the topics of segmentation, restoration, enhancement, color, and registration will be explored. Matlab projects will be utilized extensively, with an emphasis on biomedical signals and images. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 2704 (UG) OR ECE 2704

Corequisite(s):

BMES 5714:

Biomedical Microdevices

The goal of this course is to build the foundation necessary for engineering research in micro- and nano- biotechnology. The course will be broken down into four major area: micro- and nano- fabrication techniques, the fundamentals of microfluidics, micro- and nano- particle manipulation, and engineering aspects of cells and their membranes.

The culmination of the course will provide students the knowledge required to create biomedical micro- and nano- devices with a focus on the unique physics, biology and design aspects at these scales.

Students will be expected to know undergraduate engineering , physics, and calculus. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5764:

Modeling MEMS and NEMS

Modeling MEMS and NEMS is about the construction, analysis, and interpretation of mathematical and computational models microelectromechanical and nanoelectromechanical systems (MEMS and NEMS). A goal throughout the course will be to develop a physical intuition for the fundamental phenomena at these small scales. The material covered will be broad and multidisciplinary including: dimensional analysis and scaling; a review of continuum mechanics; fluid dynamics, elasticity, thermal transport and electromagnetism at the micro and nanoscales; the modeling of a variety of new MEMS/NEMS devices; and approaches beyond the continuum theory including stochastic and deterministic methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BMES 5944:

Seminar

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BMES 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BMES 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BMES 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BMES 6064:

Clinical Rotation

The course gives the student both a broad view of the use of engineering principles in medicine and general clinical care, together with an in-depth study of a particular aspect of medicine under the direct supervision of a physician. The student is allowed to observe the operation and maintenance of various clinical modalities, systems, and devices under the guidance of a working engineer or technician. The student participates in clinical rounds and image reading sessions to gain insight into the actual operation and needs of departments using medical imaging modalities. Pre: BME Ph.D. graduate students who have finished first year of study.

Credit Hour(s): 2

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s):

Corequisite(s):

BMES 6164:

Computational Modeling in Impact Biomechanics

Dynamic modeling of the human body subjected to transient impact loading. A combination of finite element analysis and multi-body simulated techniques. Utilized software packages with dynamic solvers. Applications include computer-aided design for automobile safety, sports biomechanics, and military restraint systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BMES 5164 (UG) OR ME 5754 (UG)) OR (BMES 5164 OR ME 5754)

Corequisite(s):

BMES 6174:

Advanced Human Modeling: Injury and Tissue Biomechanics

Serves as a continuation of Impact biomechanics (BMES 5164) and computational biomechanics (BMES 6164), which uses Madymo. Basics of the finite element method as it applies to high-rate phenomena. Focus will be on practical problems and the use of commercial codes for solving vehicle crashworthiness and biomechanics problems. Theory will be presented when it is useful for application to the problem. Real world examples from biomedical engineering, automobile safety, military applications, and sport biomechanics are used.

Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): (BMES 5164 OR ME 5754), (BMES 6164 OR ME 6754)
Corequisite(s):

BMES 6504:

Medical Imaging I

Medical Imaging I provides an introduction to basic imaging science and to two medical imaging disciplines: Radiography and Nuclear Medicine. Topics include: an overview of the underlying physical processes; data acquisition, sampling, and quantization; image reconstruction techniques; relationships between the various modalities; and clinical and industrial applications. Each modality is reviewed in the context of its underlying physical processors, basic imaging parameters (resolution, contrast, and noise), and medical applications. Graduate standing required.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

BMES 6514:

Medical Imaging II

Medical Imaging II provides an introduction to three medical imaging modalities: Magnetic Resonance Imaging (MRI), Computed Tomography (CT), and Ultrasound. Potential topics to be covered under emerging technologies are TeraHertz Imaging, Optical Imaging, and Molecular Imaging. Each imaging modality will cover the underlying physical processes; data acquisition, sampling, quantization; image reconstruction techniques; relationship between the various modalities; and clinical and industrial applications. Each modality is reviewed in the context of its underlying physical processes, as well as a common model describing such basic imaging parameters as resolution, contrast, and noise. Graduate standing required.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): BMES 5554
Corequisite(s):

BMES 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

BMES 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

GENETICS, BIOINFORMATICS, AND COMPUTATIONAL BIOLOGY

David Bevan, Head

Professors: Christopher Barrett; Elizabeth Grabau; Ruth Grene; Lenwood Heath; Khidir Hilu; Ina Hoeschele; Narendran Ramakrishnan; Mohammad Saghai-Marouf; Clifford Shaffer; Edward Smith; James Turner; John Tyson; Richard Veilleux; Layne Watson;

Associate Professors: Josep Bassaganya-Riera; David Bevan; Richard Helm; John Jelesko; Christopher Lawrence; Christopher North; Jean Peccoud; Adrian Sandu;

Assistant Professors: Zachary Adelman; Yang Cao; Allan Dickerman; Maria Lazar; Biswarup Mukhopadhyay; T Murali; Kevin Myles; Alexey Onufriev; Florian Schubot; Igor Sharakhov; Boris Vinatzer; Jianhua Xing; Liqing Zhang;

Affiliated Faculty: Stephen Eubank; Madhav Marathe; Henning Mortveit; Anil Vullikanti;

Graduate Contact: dennie@vbi.vt.edu

GBCB Home Page: <https://gbc.vbi.vt.edu/gbc/>

The new research paradigm exemplified by the Human Genome Project requires a new academic training paradigm, one that creates team-oriented researchers who may be specialists in one area but who are literate in several other disciplines. For example, researchers with expertise in the mathematical, statistical, or computer sciences also require sufficient knowledge in biology to understand the questions in order to develop appropriate analytical methods and computer tools. Similarly, life scientists need sufficient grounding in mathematics, statistics and computer science to be educated users of these quantitative methods and tools, and to conceptualize new tools. Research and training environments that produce such a combination of skills are not commonly found in academia. Our program is designed to

provide that training environment in genetics, bioinformatics, and computational biology. This program will allow Ph.D. students to conduct original research in the areas of genetics, bioinformatics, and computational biology. This training will enable graduates of the program to pursue careers in academia, government, or the private sector. This will be achieved through a combination of discipline-specific and cross-disciplinary course work, as well as a multidisciplinary research environment maintained by program faculty and distinguished by a high level of collaboration between disciplines. The scientific and training focus of the program is on three interdependent areas which have emerged as significant in the post-genomic era: experimental approaches and technologies for addressing complex biological questions, methods for collection, management and analysis of large biological data sets, and data-based modeling of biological systems.

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

GBCB is a Ph.D. program only, it does not offer a Master's degree. The Ph.D. degree requires a minimum of 90 total credit hours beyond the baccalaureate. Additionally, a dissertation must be written and defended before a 4-person committee. The Ph.D. plan of study is due by the end of the fourth semester of study. The distribution of the 90 required hours can be: 30-63 credit hours of research (7994 level only) 27-60 graded coursework (graduate level) For the purposes of this program and to insure that students have some breadth of exposure, four specialty tracks are defined: LIFE SCIENCES, COMPUTER SCIENCE, STATISTICS, and MATHEMATICS A student will select one of the specialty tracks as his/her primary track, which will typically be consistent with the student's undergraduate training. The other tracks will be denoted the secondary tracks for that student. Requirements will differ among the specialty tracks, with some tracks requiring more coursework, with correspondingly fewer credit hours of Research and Dissertation. In addition, a core curriculum that is common to all students has been defined: GBCB 5874 Problem Solving (3 credits) STS 5444 Issues in Bioethics (3 credits) GBCB 5004 Seminar (4 credits) A sample plan of study will include the following: Primary Track: At least 9 credit hours must be from the primary track. For students whose primary track is the Life Science track, 3 of these credit hrs must be a genomics course (e.g., CSES/GBCB 5844 - Plant Genomics) Secondary Track(s) At least 12 credit hours must be taken, with the courses coming from at least two of the three secondary tracks. For students whose primary track is not in Life Sciences, at least 6 of these credit hrs must be in the life sciences track. Students in the Statistics primary track must take CSES/GBCB 5844 or equivalent. General Electives: Choice of at least 6 credit hrs of electives Research & Dissertation: Sufficient to accumulate 90 total credit hours, minimum of 30 hours required. Examinations: All GBCB students must pass a prelim and a final exam. The preliminary exam, oral and written, is conducted by the student's

advisory committee. During the period of time between the end of the third year and end of the fourth year of study, each student must prepare a dissertation research plan and give an oral defense of that plan and the scientific foundations on which it is based. The dissertation research plan is expected to be a refinement of the initial research plan presented by the student to his committee at the end of the second year. The proposal is to be prepared in an NIH-style format and should provide a clearly defined description of the research the student plans to complete in order to fulfill the research requirement of the Ph.D. The oral defense of the plan will include questions both directly related to the proposal as well as more general questions that examine the student's knowledge of fundamental principles. The student may be tested on any aspect of his proposal, the philosophy of science, and research methodology. It is recommended that the student meet with his/her advisory committee prior to preparing for the exam to discuss the nature of the exam and evaluation procedures. The final exam, oral and written, is primarily a defense of the dissertation, but other areas of science may be included.

GRADUATE COURSES (GBCB)

GBCB 5004:

Seminar in Genetics, Bioinformatics, and Computational Biology

Review and discussion of current topics and literature in genetics, bioinformatics, and computational biology by students, Virginia Tech faculty, and outside speakers. Students give formal presentations of research results or current literature. May be repeated. Pre: graduate status in the Program in Genetics, Bioinformatics, and Computational Biology or in a department that offers the Bioinformatics Option.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 5314 (PPWS 5314):

Biological Paradigms for Bioinformatics

This course is an intensive introduction to the central paradigms of molecular cell biology for bioinformatics. Material from cell molecular biology, and genetics will be presented, and placed in a genomics context. The course prepares students in mathematical disciplines to interact in teams in the pursuit of bioinformatics research. Pre: Senior or graduate standing in mathematically-based disciplines such as computer science, statistics, mathematics or engineering.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 5424 (BIOL 5424) (CS 5424):

Computational Cell Biology

Use of mathematical models (nonlinear ordinary differential equations and stochastics processes) and simulation algorithms to explore complex feedback circuits that control the behavior of living cells. Concepts and techniques from dynamical systems theory, bifurcation analysis, numerical methods, SBML (systems biology markup language) and Matlab programming. Applications in gene regulatory networks, cell cycle control, circadian rhythms, cell signaling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5515

Corequisite(s):

GBCB 5515 (MATH 5515):

Mathematical Methods for Modeling and Simulation of Biological Systems

Introduction to mathematical techniques for modeling and simulation, parameter identification and analysis of biological systems. Emphasis on both theoretical and practical issues and methods of computation, with concrete applications. Suitable for students from the mathematical and life sciences who have a basic foundation in multivariate calculus and ordinary differential equations. 5515: Continuous models and methods. 5516: Discrete models and methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 5516:

Mathematical Methods for Modeling and Simulation of Biological Systems

Introduction to mathematical techniques for modeling and simulation, parameter identification and analysis of biological systems. Emphasis on both theoretical and practical issues and methods of computation, with concrete applications. Suitable for students from the mathematical and life sciences who have a basic foundation in multivariate calculus and ordinary differential equations. 5515: Continuous models and methods. 5516: Discrete models and methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 5844:

Plant Genomics

Comprehensive overview of genomics and its applications. Topics include: molecular markers, map construction, map-based cloning, quantitative trait loci, and functional genomics. Even years. Pre: Knowledge of general principles of genetics and molecular biology. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 5854:

Computational Systems Biology

Phenomenological and data-driven models of molecular interaction networks. Applications of graph theory, discrete algorithms, data mining, and machine learning to the modeling and analysis of molecular interaction networks. Biological applications. Interaction between biological and computational disciplines in systems biology. Must have GBCB pre-requisite and CS pre-requisites or graduate standing in CSA or equivalent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 4104 OR CS 4104 (UG) OR CS 5046, GBCB 5314

Corequisite(s):

GBCB 5874:

Problem Solving in Genetics, Bioinformatics, and Computational Biology

Research practicum in genetics, bioinformatics, and computational biology. Emphasis on the multidisciplinary and collaborative nature of research in genetics, bioinformatics, and computational biology. Exposure to the scientific method, the nature of research tools, strategies for publishing, and opportunities for research careers in genetics, bioinformatics, and computational biology. Permission required.

Credit Hour(s): 3

Lecture Hour(s): 3

88 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

GBCB 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 9

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GBCB 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

INFORMATION TECHNOLOGY

Parviz Ghandforoush, Head

Professors: Parviz Ghandforoush; Randolph Marchany; Timothy Pratt; Cliff Ragsdale;

Associate Professors: Lynn Abbott; William Frakes; Devi Gnyawali; Donald Hatfield; Lance Matheson; Steven Sheetz; Luiz Silva; Linda Tegarden;

Assistant Professors: Gregory Kulczykcki;

General Contact: vtmitinfo@vt.edu

Graduate Site: <http://mit.iddl.vt.edu/>

The online graduate program in Information Technology offers an essential upgrading of skills to working professionals desiring to

participate in the rapidly expanding area of information technology. It is a unique interdisciplinary degree program offered collaboratively by Virginia Tech's College of Engineering and the Pamplin College of Business. The VTMIT program uses a combination of synchronous and asynchronous communication that provides faculty-to-student, and student-to-student interaction that is comparable to a live classroom. The program is an innovative blend of coursework in seven related information technology modules that are updated regularly to reflect industry changes. Students may pursue the Master of Information Technology degree, or choose to enroll as a non-degree student if looking to increase their expertise in a specific concentration.

SPECIAL FACILITIES

The graduate program in Information Technology is only offered in an online format.

DEGREES OFFERED

MIT Degree

Offered In (Virtual)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Thirty credits are required for the Master of Information Technology degree. Each student must complete three of seven modules for a total of 18 credit hours, in addition to the four required foundation courses totaling 12 credit hours. Modules include Information Security, Networking, Software Development, Business Information Systems, Decision Support Systems, Telecommunications, and Healthcare Systems. The required foundation courses include Object-Oriented Programming with Java, Software Engineering, Fundamentals of Computer Systems, and Strategic Leadership in Technology-Based Organizations. Successful completion of an individual graduate certificate requires between 9 and 12 credit hours in total, consisting of 3-6 credit hours for the relevant foundation course, plus the selected module.

MACROMOLECULAR SCIENCE AND ENGINEERING

Judy Riffle, Program Director

Professors: Donald Baird; David Dillard; Kevin Edgar; Charles Frazier; Richard Gandour; Harry Gibson; James Hefflin; Erdogan Kiran; Donald Leo; Timothy Long; Herve Marand; James McGrath; Joseph Merola; Robert Moore; Judy Riffle; Sam Turner;

Associate Professors: Justin Barone; Scott Case; Richey Davis; Paul Deck; Michael Ellis; Alan Esker; Aaron Goldstein; Eva Marand; John Morris; Audrey Zink-Sharp;

Assistant Professors: Bahareh Behkam; Louis Madsen; Stephen Martin; John Matson; Amrinder Nain; Mark Paul; Padmavathy Rajagopalan; Scott Rennekar;

Maren Roman; Abby Whittington;

Harry C. Wyatt Professor of Chemical Engineering: Donald Baird;

Thomas M. Brooks Professor of Wood Science and Forest Products: Charles Frazier;

University Distinguished Professor: James McGrath;

General Contact: cyndy@vt.edu

Student Handbook: <http://www.mii.vt.edu/MACR/index.html>

The Macromolecular Science and Engineering (MACR) graduate programs are interdepartmental, intercollegiate M.S. and Ph.D. degrees focused on polymer science and engineering. The programs are interdisciplinary in nature with faculty members from the Colleges of Science, Engineering, and Natural Resources. Students work under the direction of faculty in the departments of Chemistry, Physics, Sustainable Biomaterials, Chemical Engineering, Materials Science Engineering, Mechanical Engineering, Engineering Science and Mechanics, and Civil Engineering. Students working under the direction of these faculty may pursue the departmental curricula or the Macromolecular Science and Engineering curriculum to earn degrees in the respective programs. The MACR curriculum is designed to offer the flexibility needed to tailor interdisciplinary programs of study to emerging areas related to polymeric materials. Students may choose from four fundamental modules (Synthesis, Structure, Processing, or Mechanics of Polymers) or from a series of emerging technological domains (Polymers in Materials Medicine, Adhesion and Interfaces, Opto- and Micro-electronics, or Composites) to build technical depth. Breadth is gained through polymer courses outside the concentration area, as well as through elective coursework and research. In addition to the technical courses, the program emphasizes the development of technical oral and written communication skills, team building and leadership skills, and the option to build awareness of business practices in the polymer industries through a targeted course in this area.

SPECIAL FACILITIES

Facilities include laboratories in the ICTAS building and Hahn Hall.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Master's (M.S.) * MACR 5015/5016: Macromolecular Fundamentals with Laboratory I/II (3 cr) (sample 5015 syllabus, sample 5016 syllabus)* CHEM/CHE 5014 : Technical Oral Communications and Presentation Methods (1 cr.) (sample syllabus)* MACR 5024: Writing Skills for Macromolecular Science and Engineering (1 cr.) (sample syllabus)* Technical Concentration Area (6 cr. from one program module)* MACR Elective Courses (4 cr. from any remaining program modules)* MACR

5994: Research and Dissertation (minimum of 10 cr.)Total Program Hours: 32Advancement to Candidacy Requirements (M.S.)* By the end of the 2nd academic semester in residence, the student will submit an approved Plan of Study and 1st evaluation after meeting with their major professor.* By the end of the 4th academic semester in residence, the student is expected to meet with their committee and submit a 2nd evaluation.* At least once per year thereafter, the student is expected to submit an annual evaluation until the student is ready to defend his/her thesis.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Doctor of Philosophy (Ph.D.) * MACR 5015/5016: Macromolecular Fundamentals with Laboratory I/II (3 cr) (sample 5015 syllabus, sample 5016 syllabus)* CHEM/CHE 5014 : Technical Oral Communications and Presentation Methods (1 cr.) (sample syllabus)* MACR 5024: Writing Skills for Macromolecular Science and Engineering (1 cr.) (sample syllabus)* Technical Concentration Area (9 cr. from one program module)* MACR Elective Courses (6 cr. from any remaining program modules)* General Electives (9 cr.)* MACR 7994: Research and Dissertation (minimum of 58 cr.)Total Program Hours: 90Advancement to Candidacy Requirements (Ph.D.)* By the end of the 2nd semester in residence, students will submit 1st evaluation after meeting with their major professor.* By the end of the 3rd academic semester in residence, students will submit approved Plan of Study.* By the end of the 4th academic semester in residence, students will write a literature review for their dissertation project, then defend that review orally before their committee.* By the end of the 5th academic semester in residence, students are required to pass a combined written and oral examination focusing on questions pre-submitted by the dissertation committee.* At least once per year thereafter, the student will orally review his or her research before the dissertation committee (this requirement is due to the highly interdisciplinary nature of the research).

GRADUATE COURSES (MACR)

MACR 5015:

Macromolecular Fundamentals Laboratory I and II

The course will cover fundamentals and experimental techniques for the synthesis and characterization of polymeric materials. MACR 5015 includes statistical experimental design, step-growth and chain-growth polymerization, molecular modeling, thermal properties of polymers, molecular weight analysis, morphology, and melt and solution rheology. MACR 5016 includes static and dynamic mechanical analysis, rubber elasticity, spectroscopy, surface analysis, fracture behavior, and basic polymer processing. Must meet pre-requisites or equivalent.

Credit Hour(s): 0 OR 3
Lecture Hour(s): 0 OR 2
Instruction Type(s): Lab, Lecture
Instruction Type(s): Lab, Lecture
Prerequisite(s): CHEM 4534 OR CHEM 4634 OR CHE 4104
Corequisite(s):

MACR 5016:

Macromolecular Fundamentals Laboratory I and II

The course will cover fundamentals and experimental techniques for the synthesis and characterization of polymeric materials. MACR 5015 includes statistical experimental design, step-growth and chain-growth polymerization, molecular modeling, thermal properties of polymers, molecular weight analysis, morphology, and melt and solution rheology. MACR 5016 includes static and dynamic mechanical analysis, rubber elasticity, spectroscopy, surface analysis, fracture behavior, and basic polymer processing. Must meet pre-requisites or equivalent.

Credit Hour(s): 0 OR 3
Lecture Hour(s): 0 OR 2
Instruction Type(s): Lab, Lecture
Instruction Type(s): Lab, Lecture
Prerequisite(s): CHEM 4534 OR CHEM 4634 OR CHE 4104
Corequisite(s):

MACR 5024:

Writing Skills in Macromolecular Science and Engineering

This course focuses on methods and critiques for preparing technical abstracts, conference proceedings, technical industrial reports, refereed journal manuscripts and resumes.

Credit Hour(s): 1
Lecture Hour(s): 2
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

MACR 5974:

Independent Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

MACR 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lab, Lecture
Instruction Type(s): Lab, Lecture
Prerequisite(s):
Corequisite(s):

MACR 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

MACR 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

MICROBIOLOGY GRADUATE TRAINING PROGRAM

Professors: Jiann Shin Chen; Dennis Dean; Joseph Falkinham; Charles Hagedorn; Thomas Inzana; Charles Johnson; Peter Kennelly; Timothy Larson; Liwu Li; Xiang-Jin Meng; David Popham; Nammalwar Sriranganathan; Ann Stevens; Erik Stromberg; Sue Tolin; Zhijian Tu; Gregory Welbaum; Keith Yoder;
Associate Professors: Zachary Adelman; Kathleen Alexander; Joseph Eifert; Michael Klemba; Stephen Melville; Biswarup Mukhopadhyay; Kevin Myles; Sally Paulson; Paul Roberts; Boris Vinatzer; Robert White; Robert Williams; Zhaomin Yang;
Assistant Professors: Maria Cassera; Marcy Hernick; Monica Ponder; Birgit Scharf;

General Contact: dennie@vt.edu

Graduate Contact: melville@vt.edu

Graduate Site: <http://www.vtmicro.biol.vt.edu/index.html>

The study of the biology of microorganisms has a long tradition at Virginia Tech. In fact, the first advanced degree given at the university

was awarded in Bacteriology in 1891. If you are searching for a university where you can enhance your scientific career by undertaking postgraduate research toward a PhD degree, you will find that Virginia Tech can offer you exciting and rewarding options. There are a large number of Virginia Tech faculty members carrying out research with microorganisms. These faculty members are located in several different departments and their locations reflect to a large extent the diversity of their research interests. You will find research being carried out in microbial ecology; in the relationship of microorganisms to diseases in plants, animals, and humans, as well as to bioterrorism and emerging diseases; in the problems associated with microorganisms in food; in the many roles microorganisms play in agriculture; and in the fundamental nature of the microbial cell, to name just a few. (Faculty Research Interests) Due to the diverse nature of Microbiology research, students accepted into the VA Tech Microbiology Graduate program have the opportunity to spend "lab rotation" time in three different research labs around campus during their first semester. They then choose the lab in which they will carry out their Ph.D. dissertation research and enter the graduate program of that department. All students admitted into the program are supported with a monthly stipend with tuition fully paid.

SPECIAL FACILITIES

In addition to individual faculty research labs, there are many common research resources available across campus. Some of those are listed here: Electron Microscopy/Morphology Service Laboratory (<http://www.vetmed.vt.edu/Organization/Research/Resources/morphology.asp>) Flow Cytometry Resource Laboratory (<http://www.vetmed.vt.edu/Organization/Research/Resources/flow.asp>) Keck Confocal Microscope Facility (http://www.biotech.vt.edu/research/keck_microscope.html) Virginia Tech Mass Spectrometry Incubator (<http://www.mass.biochem.vt.edu>) Virginia Bioinformatics Institute Core Laboratory Facility (https://www.vbi.vt.edu/core_laboratory_facility) Core Computational Facility (<https://www.vbi.vt.edu/article/articleview/88>)

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal+Quantitative (Old Scale) (1000.0),

Verbal+Quantitative (Current Scale) (305.0)

The Virginia Tech Interdepartmental Microbiology Program offers training in all areas required for the development of successful scientists. Research: During your first semester you will perform research rotations in three laboratories, chosen from a broad range of topic areas. Following those rotations, you will come to a mutual choice with a faculty member to enter their lab and complete your dissertation research. The average time for students to complete the Ph.D. program is 5 years. Teaching and Presentation skills: All graduate students are required to spend at least one semester as a graduate teaching assistant, generally supervising an undergraduate teaching laboratory. All students have numerous opportunities to develop their presentation skills under

non-stressful conditions. First year students give short 10-minute talks describing their research rotation projects. More advanced students present seminars describing their research projects or related topics. Students are expected to participate in lab group meetings and journal clubs to present and discuss the most recent research methods and discoveries. All this prepares the student to present their research at national and international research conferences. Coursework: The plan of study for each student is based on their prior experience and their future interests. Students are required to complete 18 graded credit hours in advanced courses (generally 6 courses). Students will take 2-3 courses each semester of their first year and 1-2 courses each semester in their second year. The remainder of their time is spent in the research labs. In addition to the courses listed below, each year there are several specialized courses offered that examine the most recent research advances within various fields of study. BCHM 5054 Molecular Biology of Prokaryotic Gene Regulation BCHM 5115-5116 Principles of Biochemistry BCHM 5204 Molecular Biology of Eukaryotic Gene Expression BCHM 5214 Molecular Biology of the Cell BIOL/CSES/CEE 4164 Environmental Microbiology BIOL (FST) 4604 Food Microbiology BIOL 4644 Microbial Molecular Genetics and Physiology Laboratory BIOL 5664 Advanced Virology BIOL 4704 Immunology BIOL 4734 Inflammation Biology BIOL 4714 Immunology laboratory BIOL 5804 Advanced Prokaryotic Diversity BIOL 5624 Advanced Microbial Genetics BIOL 5634 Advanced Microbial Physiology BIOL 5674 Advanced Pathogenic Bacteriology BIOL 6634 Topics in Microbial Ecology BIOL 6644 Topics in Microbial Genetics BIOL (PPWS) 6654 Topics in Virology BIOL (VMS) 6704 Topics in Immunology CEE 5194 Applied Biology of Environmental Systems FST 5604 Advances in Food Microbiology PPWS 5054 Plant Pathogenic Agents PPWS 5204 Principles of Plant Disease Management PPWS 5214 Diseases of Crop Plants VMS 5024 Selected Topics in Veterinary Pathogenic Bacteriology VMS 5044 Veterinary Immunology VMS 5054 Veterinary Virology

MOLECULAR PLANT SCIENCES

Bingyu Zhao, Head

Professors: Eric Beers; Glenda Gillaspay; Elizabeth Grabau; Ruth Grene;

Chuanxue Hong; Charles Johnson; Mohammad Saghai-Maroo; Richard Veilleux;

James Westwood; Brenda Winkel;

Associate Professors: Amy Brunner; John Jelesko; Christopher Lawrence; David

Schmale; Dorothea Tholl; Boris Vinatzer;

Assistant Professors: Eva Colla'kova'; Jason Holliday; Sakiko Okumoto;

Guillaume Pilot; James Tokuhisa;

Graduate Contact: dennie@vt.edu

Graduate Site: <http://www.molplantsci.org.vt.edu/>

The Molecular Plant Scientists at Virginia Tech welcome you. We are a group of more than twenty faculty and many more students in seven departments in the Colleges of Agriculture, Science, and Natural Resources. All of us use molecular approaches to understand how plants grow and interact with their environments. Our Graduate Program in Molecular Plant Sciences allows students interested in pursuing a Ph.D. in this discipline to work in a wide variety of research areas

ranging from plant genomics to disease resistance, metabolic engineering, bioproduction and bioprocessing, and forest biotechnology. Degree candidates who enroll in the program will participate in several rotations through laboratories of interest. The program of study will include selections from a range of course offerings, tailored to the background and interests of each student. At the end of the first or second semester of enrollment, a permanent advisor is selected in whose laboratory the dissertation research will be conducted. The student then will become a doctoral student in the advisor's home department. (eg. Biochemistry, Forestry, Horticulture, etc.) Thus, the student will receive the doctoral degree from that specific department. The diversity in our programs becomes evident looking at the federal agencies that fund them: National Science Foundation, United States Department of Agriculture, Department of Energy, and National Institute of Health. Moreover, many laboratories are also supported by various Virginia and US grower organizations and industry.

SPECIAL FACILITIES

Latham Hall was dedicated in 2006. This 84,000-square-foot, state-of-the-art agriculture and natural resources research facility, provides greatly expanded and fully outfitted laboratory space, a large number of controlled-environment chambers, soil and plant material preparation areas, conference rooms, and faculty offices.

Latham Hall

Latham Hall was dedicated in 2006. This 84,000-square-foot, state-of-the-art agriculture and natural resources research facility, provides greatly expanded and fully outfitted laboratory space, a large number of controlled-environment chambers, soil and plant material preparation areas, conference rooms, and faculty offices.

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

All Ph.D. students must pass a preliminary exam and a final exam. Procedures and requirements for completing these exams are contained in your specific department's Graduate Program Procedures and the Graduate Catalog. The preliminary exam, oral and/or written, is conducted by the student's advisory committee. It is comprehensive in nature and is intended to test a student's ability to integrate, synthesize, and apply concepts, facts, and techniques in solving new and complex problems associated with molecular plant sciences. The student may be tested on any aspect of relevant science, the philosophy of science, and research methodology. It is recommended that the student meet with his/her advisory committee prior to preparing for the exam to discuss the nature of the exam and evaluation procedures. The final exam is primarily a defense of the dissertation, but other areas of science may be included.

BIOLOGICAL SCIENCES

Brenda Winkel, Head

Professors: Ernest Benfield; Arthur Buikema; Joseph Falkinham; Michael Friedlander; Harold Garner; Khidir Hilu; Roderick Jensen; Liwu Li; Erik Nilsen; Brent Opell; John Phillips; David Popham; Jill Sible; Ann Stevens; John Tyson; Jeffrey Walters; Jackson Webster; Brenda Winkel;

Associate Professors: John Barrett; Lisa Belden; Daniel Capelluto; Daniela Cimini; Carla Finkielstein; Michael Fox; Dana Hawley; Christopher Lawrence; Maria Lazar; Stephen Melville; Ignacio Moore; Florian Schubot; Dorothea Tholl; Richard Walker; Jianhua Xing; Zhaomin Yang;

Assistant Professors: Bryan Brown; Cayelan Carey; Silke Hauf; Deborah Kelly; Shihoko Kojima; Adi Livnat; Joel McGlothlin; Konark Mukherjee; Zachary Nimchuk; Birgit Scharf; Kendra Sewall; Michael Strickland; Gregorio Valdez;

Alumni Distinguished Professor: Arthur Buikema;

University Distinguished Professor: John Tyson;

Harold Bailey Professor: Jeffrey Walters;

Graduate Contact: BiologyGrad@vt.edu

Graduate Site: <http://www.biol.vt.edu/graduates/index.html>

Graduate Course Descriptions:

http://www.biol.vt.edu/graduates/course_descriptions/graduate_course_descriptions.html

The Department of Biological Sciences offers research and training that lead to the M.S. and Ph.D. degrees. Graduate students, in consultation with Major Advisors, design programs of study that include cutting edge research, courses that support their particular interests, and at least one semester of a teaching experience. Opportunities for research span the biological disciplines from molecular biology to ecosystems ecology and may include computational, experimental, theoretical, and/or applied approaches. Our faculty members encourage graduate students to reach their full creative and scholarly potential. We take a holistic approach to graduate education by promoting both research skills and the ability to communicate effectively with professional colleagues and undergraduate students. In addition to their research program, graduate students may elect to earn a graduate certificate in "The Future Professoriate," which includes mentored classroom teaching. In short, our program fosters individually tailored programs that lead to successful careers in research and education. We encourage prospective students to visit the department's webpage to learn about research focus areas and associated interdepartmental programs, and to explore the research programs of potential Major Advisors by perusing faculty web pages. Contacting individual faculty members and their students prior to formal application provides opportunities to explore mutual interests. Deadlines To compete for financial aid, applications for fall admission must be completed by December 31 for international applicants and February 1 for domestic applicants. Applications are accepted after this date but the opportunities for financial aid are diminished. Most graduate teaching assistantships are awarded by April 1. October 31 is the deadline for spring semester applications (domestic students). We do not accept

international applications for spring semester.

SPECIAL FACILITIES

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DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

M.S.: Must take a minimum of 12 hours at the 5000 level, and a maximum of 3 hours at the 4000 level, and 3 additional hours for seminars for a total of 18 graded hours, plus 12 hours research and thesis. Thesis is required. All biology graduate students must teach a minimum of one semester as a requirement for graduation.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

Ph.D.: Must take a minimum of 18 graded course hours at the 5000 level and 4 additional hours for seminars for a total of 22 graded hours, plus 68 hours research and dissertation. All biology graduate students must teach a minimum of one semester as a requirement for graduation.

GRADUATE COURSES (BIOL)

BIOL 5024:

Population and Community Ecology

Population dynamics, interspecific interactions, succession, and diversity of plants and animals. Quantitative approaches emphasized. Ecology course required. II

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5034:

Ecosystem Dynamics

Application of a systems perspective to functional characteristics of ecosystems. Laboratory: computer simulation of ecosystem dynamics. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (MATH 2015 (UG), CS 1014 (UG)) OR (MATH 2015, CS 1014)

Corequisite(s):

BIOL 5044:

Aquatic Ecotoxicology

Techniques for evaluating polluted aquatic ecosystems, including laboratory toxicity testing and field biological monitoring, and the development of criteria for maintaining water quality. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5064 (ALS 5064) (PPWS 5064) (BCHM 5064):

Seminar in Molecular Cell Biology and Biotechnology

Review and discussion of current problems and literature in molecular cell biology and biotechnology by students, VPI&SU faculty and outside speakers. Students give formal presentations of research results or current literature. May be taken on pass-fail basis. Students enrolled in the MCBB Ph.D. option will be required to give one formal presentation on an A-F basis. Graduate status in participating MCBB departments required. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5074:

Stream Ecology

Application of ecological principles to running water environments.

Recitation: critical assessment of contemporary literature and research themes associated with stream ecosystems. Graduate standing required.

Credit Hour(s): 0 OR 4

94 Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5084:

Groundwater Ecology

Application of hydrologic and ecological principles to groundwater environments to address the biodiversity and processes of subsurface aquatic ecosystems. Recitation: assessment of primary literature directed at the ecology of groundwater systems. Graduate standing required.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5094:

Stable Isotopes in Ecology

Application of stable isotope methods and interpretations to studies of ecosystem structure and function. Recitation: critical assessment of contemporary literature and research themes associated with applications of stable isotopes to ecological research. Graduate standing required.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5104:

Advanced 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. Review of the current literature. Pre-requisite: Graduate standing required.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5114G:

Advanced Global Change Ecology

Human alterations of climate, landscapes and biogeochemical cycling influence ecological structure and functioning at the global scale. Such changes have the potential to disrupt natural and managed ecosystems with potentially significant biological and economic impacts. This course will examine the influences of these global changes on the ecosystem processes and biodiversity, drawing on paleo- and contemporary examples. Current and future potential feedbacks between biological systems and the global environment will also be addressed. Pre-requisite: Graduate Standing required

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5134G:

Advanced Evolutionary Genetics

Genetic variation, agents of change in gene frequencies, molecular evolution, mechanisms of speciation, ecological speciation. Comparison of theoretical models with natural and laboratory populations. Graduate standing required.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5154:

Exercises in Grantsmanship

All aspects of obtaining grant funding in the sciences. Grant writing, ethics, development of proposals for national funding agencies, the peer review system, and participation in a mock grant panel meeting. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5164:

Biology Seminar Lab

A practicum in the preparation and presentation of formal scientific seminars. Graduate standing required. II

Credit Hour(s): 1

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s):

Corequisite(s):

BIOL 5174:

Graduate Seminar

Offered in the major subdisciplines of biology. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5184:

Prokaryot Recombinant Proteins

Concepts of bacterial recombinant protein expression, purification, and handling. Protein bioinformatics resource and the functional characteristics of proteins with biochemical and biophysical techniques. Discussion of research articles related to class topics. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 4115

Corequisite(s):

BIOL 5214:

Biomacromolecular Structure

Analysis of biomacromolecular interactions using X-ray crystallography data. Acquisition, processing, refinement, and validation of biomacromolecular structures. Conformational search methods. Simulation of folding/unfolding thermodynamics. Use of protein structure databases. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIOL 3204

Corequisite(s):

BIOL 5304:

Plant Stress Physiol

Analysis of physiological responses of agricultural and native plants to environmental stresses such as extremes of temperature, availability of water and nutrients, and presence of air pollutants. Emphasis on linking stress caused changes in carbon gain, water loss, nutrient utilization, and energy balance with changes in growth. Laboratory to introduce equipment and research approaches used in greenhouse and field studies. II

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5314:

Advanced Plant Ecology

The ecology of terrestrial plants in natural systems including major plant functional types, macromolecular plant ecology, behavior of populations, responses of plant communities to disturbance, vegetation analysis, and ordination; discussion of current research papers. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5334:

Advanced 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 between plants and other organisms; effects of global change on chemical interactions; and engineering of natural chemical defenses in sustainable agriculture. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5384:

Morphometrics

Study of shape and size in fossil and modern organisms with strong focus on quantitative methods and digital image analysis. Covers

analytical methods (multivariate methods, Fourier analysis, geometric morphometrics), image processing, and software training (SAS, SAS/IML, and Imaging Software).

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (STAT 5004 (UG), GEOS 5374 (UG)) OR (STAT 50004, GEOS 5374)

Corequisite(s):

BIOL 5404:

Neuroethology

Overview of Neuroethology, the study of the neural basis of animal behavior. Topics include: organization of the nervous system, control and coordination of movement, sensory transduction, visual and auditory prey detection and recognition, visual communication, matched filters/predictive coding of sensory information, learning templates, computational maps, sensory integration, behavioral plasticity, spatial cognition, neural plasticity, and lateralization of neural function.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5424 (GBCB 5424) (CS 5424):

Computational Cell Biology

Use of mathematical models (nonlinear ordinary differential equations and stochastic processes) and simulation algorithms to explore the complex feedback circuits that control the behavior of living cells. Concepts and techniques from dynamical systems theory, bifurcation analysis, numerical methods, SBML (systems biology markup language) and Matlab programming. Applications in gene regulatory networks, cell cycle control, circadian rhythms, cell signaling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5515

Corequisite(s):

BIOL 5434:

Behavioral Endocrinology

Overview of the hormonal basis of animal behavior. Topics include: sex differences in behavior, male and female reproductive behavior, parental

behavior, aggressive and other social behaviors, stress, affective disorders, learning and memory, homeostasis, and biological rhythms.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5564:

Adv Infectious Disease Ecology

Advanced overview of the principles of infectious disease dynamics from ecological and evolutionary perspectives. Examines a variety of wildlife hosts and disease-causing agents. 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-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5624G:

Advanced Microbial Genetics

Molecular genetics of bacteria and their associated plasmids and phages. Review of research from the current literature for methodology and standards of data analysis. Graduate standing required.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5634:

Microbial Physiology

The study of the structure, function and metabolic activities of prokaryotic microorganisms. Topics covered include cell composition and growth, metabolic unity and diversity, patterns of regulation, transport mechanisms, environmental sensing and response and cellular differentiation processes. Students will give presentations and critically analyze current literature in the field.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5664G:

Advanced Virology

Classification, structure, replication, and pathogenesis of viruses of animals, plants and bacteria. Epidemiology, prevention, and treatment.

Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5674G:

Advanced Pathogenic Bacteriology

Characteristics of bacteria that cause human disease, nature of infectious processes, virulence factors, epidemiology, resistance, immunization. Review of publications in the current literature related to data and statistical analysis and methods. Graduate standing required.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5734:

Advanced 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, neurological diseases and sepsis. Therapeutic intervention of inflammatory diseases. Discussion of current literature. Integrative approaches to study of inflammation will be critically evaluated and synthesized. Pre-requisite: Graduate Standing required.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5804G:

Adv Prokaryotic Diversity

The study of the vast array of physiological, morphological, and behavioral properties of prokaryotes, i.e., the Bacteria and the Archaea, that enables them to compete successfully in nature and, in many instances, to complement each other. Topics covered include the modern classification of prokaryotes and show how their widely diverse properties have contributed to a better understanding of cell and molecular biology and biochemistry, how they have been useful in industry and agriculture, and how they are important for continued life in our biosphere. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5844:

Advanced 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. Includes three 4-hour lab sessions. Pre-requisite: Graduate Standing required.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5854G:

Advanced Cytogenetics

Structure and function of eukaryotic chromosomes, with emphasis on (i) use of model systems to study specific chromosomes 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-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5864:

Physical Chemistry of the Cell

Applications of classical thermodynamics, chemical kinetics, and statistical mechanics in molecular and cellular processes. Pre-Requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5884:

Molecular Biology of the Cell

Current concepts of the molecular organization of animal and plant cells.

Topics include membrane structure and function, organelle biosynthesis and function, intracellular signaling, the cytoskeleton, the cell cycle, tissue formation and modern experimental methodologies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BIOL 3774 (UG) OR BCHM 4116 (UG)) OR (BIOL 3774 OR BCHM 4116)

Corequisite(s):

BIOL 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BIOL 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BIOL 6004:

Topics in Ecology and Systematics

Reading and discussion in a specific area of ecology and systematics.

Topic will vary, and course may be taken for credit more than once.

Background in ecology or systematics required. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 6014:

Topics in Evolutionary Biology

Readings and discussion in a specific area of evolutionary theory, ecological genetics, or molecular evolution. Topics will vary, and course may be taken for credit more than once. Background in genetics and population biology required. II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 6024:

Topics in Molecular Cell Biology and Biotechnology

Specific areas such as the molecular biology of plant and animal disease resistance, of photosynthesis, of oncogenes, of organelle assembly, and of growth and development, structure and function of polyamines and of proteases will be discussed. Students will give presentations and critically analyze current literature. May be repeated. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5214 (UG) OR BCHM 5214

99 Corequisite(s):

BIOL 6064:**Topics in Freshwater Ecology**

Readings and discussion in a specific area of freshwater ecology, including species interactions, and community level functions. Topics will vary, and course may be taken for credit more than once. II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIOL 4004

Corequisite(s):

BIOL 6084:**Topics in Cell and Developmental Biology**

Readings and discussion of a focused area of cellular and developmental biology, including cell signaling, cell cycle, differentiation and morphogenesis, cytoskeletal regulation and cell death. Topics vary each semester and course may be repeated with different content up to a maximum of 12 credits. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIOL 5884 OR BIOL 4104 (UG) OR BIOL 4104

Corequisite(s):

BIOL 6404:**Topics In Vertebrate Biology**

Readings and discussion in a specific area of vertebrate biology. Topic will vary, and course may be taken for credit more than once.

Background in vertebrate biology required. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 6644:**Topics in Microbial Genetics**

Readings and discussion in a specific area of microbial genetics, including temperate bacteriophage, insertion elements and transposons, gene function in prokaryotic microorganisms, and mechanisms of genetic recombination. Topic will vary and course may be taken for credit more than once. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIOL 4624 (UG) OR BIOL 4624

Corequisite(s):

BIOL 6704:**Topics in Immunology**

Readings and discussion in a specific area of immunology. Topic will vary and course may be taken for credit more than once. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIOL 4704 (UG) OR BIOL 4704

Corequisite(s):

BIOL 6984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BIOL 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BIOMEDICAL TECHNOLOGY DEVELOPMENT AND MANAGEMENT

Kenneth Wong, Program Director

Graduate Contact: kh Wong@vt.edu

Graduate Site: <http://btdm.ncr.vt.edu/>

The Master of Science in Biomedical Technology Development and Management prepares students to meet the challenges of current and future directions in medical product discovery and development and the emerging needs of industry and government. The degree program

provides a balance of scientific and management courses that prepare students to critically evaluate biomedical technologies, advance their own careers, and create new startup ventures. Classes are taught primarily in the evenings and on weekends to meet the needs of working professionals. Online and hybrid classes are also part of the program. The technical curriculum covers topics such as immunology, pharmacology, bioinformatics, neuroscience, biomaterials, molecular biotechnology, and medical imaging. Topics in the management curriculum include commercialization, intellectual property, ethics, project management, regulatory agencies, clinical trials, technology licensing, and finance. Students in their second year are encouraged to take on an independent project focused on either science or business development.

SPECIAL FACILITIES

BTDM classes are taught partly at Virginia Tech's Northern Virginia Center, located near the West Falls Church Metro station, and partly at the Virginia Tech Research Center, located near the Ballston Metro station. Some classes are also offered online.

DEGREES OFFERED

MS Degree

Offered In (National Capital Region)

GRE

General Test: Verbal, Quantitative, Analytical

The Master of Science in Biomedical Technology Development and Management requires 30 semester hours. Many of the classes require independent projects and group presentations, since the ability to analyze information, think critically, and communicate effectively is essential for future career success.

GRADUATE COURSES (BTDM)

BTDM 5214:

Human Immunology

The purpose of the course is to provide an understanding of how the immune system recognizes foreignness outside and inside the body; the tissue damaging consequences of the immune system when it fails to distinguish between non-self and self and the value of immunological reagents in diagnosis and treatment of disease. Pre: graduate standing in the Master of Science in Biomedical Technology Development and Management Program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BTDM 5224:

Principles of Pharmacology

This course introduces the fundamentals of pharmacology and clinical therapeutics by consideration of pharmacodynamic, pharmacokinetic and biopharmaceutical principles. The course includes physiochemical and biological factors affecting drug action; the absorption, distribution, metabolism and excretion of drugs and the physical and physiological conditions to be considered in drug formulations. Pre: graduate standing in the Master of Science in Biomedical Technology Development and Management Program.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BTDM 5234:

Pre-Clinical and Clinical Product Evaluation

This course will first introduce approaches to preclinical drug evaluation methods including in vitro, in silico, and animal models of human toxicity. The course will then consider the design, conduct, interpretation, and analysis of clinical trials, including statistical, regulatory and ethical considerations. Pre: Graduate standing in the Master of Science in Biomedical Technology Development and Management Program.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BTDM 5244:

Biomedical Device Discovery and Development

This seminar course will cover a wide spectrum of devices from imaging systems and integrated surgical platforms to health enterprise networks to microscale implantable devices. The course will focus on the technology and clinical impact of a device, along with the economic and regulatory processes involved in bringing a device from the research laboratory to the marketplace. Pre: STAT 5674 and graduate standing in Master of Science in Biomedical Technology Development and Management program.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5674 OR STAT 5674 (UG)

Corequisite(s):

BTDM 5254:

Drug Discovery and Product Development

This seminar course in drug discovery and development covers both therapy and diagnostics. It will focus on the scientific, clinical, economic and regulatory processes as well as stewardship involved in bringing a drug from the laboratory to the marketplace. Pre: STAT 5674 and graduate standing in Master of Science in Biomedical Technology Development and Management program.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BTDM 5314:

Molecular Biology Foundations

Industrial processes using cells or biological systems for the production of compounds, principles of information flow in cells, recombinant DNA technology, hybridoma technology, gene, cell, and protein engineering, and applications of biotechnology in different industrial sectors. Economic and ethical ramifications of biotechnology and the protection of intellectual property involving biotechnology inventions. Pre: Graduate standing.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BTDM 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BTDM 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BTDM 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEMISTRY

James Tanko, Chair

Emeriti Faculty: Harold McNair;

Professors: Karen Brewer; Paul Carlier; Daniel Crawford; Harry Dorn; Alan Esker; Felicia Etzkorn; Richard Gandour; Harry Gibson; Brian Hanson; David Kingston; Timothy Long; Herve Marand; Joseph Merola; Robert Moore; John Morris; Judy Riffle; James Tanko;

Associate Professors: Paul Deck; Gary Long; Louis Madsen; Webster Santos; Brian Tissue; Diego Troya; Eduard Valeyev; Gordon Yee;

Assistant Professors: Tijana Grove; Jatinder Josan; Guoliang Liu; John Matson; Amanda Morris;

University Distinguished Professor: David Kingston;

Dr. A. C. Lilly, Jr., Faculty Fellow of Nanoscience: Harry Dorn;

Research Professors: Sam Turner;

Blackwood Junior Faculty Fellow of Life Sciences: Webster Santos;

Graduate Contact: jolih@vt.edu

Graduate Program Director: jrmorris@vt.edu

Graduate Admissions Director: gandour@vt.edu

Graduate Site: <http://www.chem.vt.edu/grad/index.html>

Student Handbook: <http://www.chem.vt.edu/grad/grad-documents/grad-orange-book.pdf>

Admissions: <http://www.chem.vt.edu/grad/grad-admissions.html>

The Chemistry Department is consistently top-ranked among its peers in terms of degree production (BA, BS, MS, & PhD) and research expenditures. Our 30 faculty members and 170 graduate students generate over 100 peer-reviewed publications per year and have earned numerous prestigious awards for research, teaching, and outreach. In addition to the major areas of chemistry (analytical, inorganic, organic, and physical), our polymer chemistry program has been ranked among the top 5, and we have highly developed programs in several interdisciplinary areas including drug discovery, computational and

theoretical chemistry, surface science, renewable energy, and chemical biology.

SPECIAL FACILITIES

The Chemistry Department is housed in three adjoining buildings. Davidson Hall is the original chemistry building, which is presently undergoing renovation and will be available for use in January 2014. Davidson Hall features both classrooms and research laboratories. Hahn Hall South Wing is exclusively devoted to research, and the building features a lovely atrium gathering space. Hahn Hall North Wing houses our teaching laboratories and several conference rooms. Additional research space is occupied by the Chemistry Department in the Institute for Critical Technologies and Applied Science (ICTAS) and the Virginia Tech Corporate Research Center (CRC). Other equipment available to Chemistry researchers includes an 1100-node supercomputer (System X), several smaller computational clusters and a broad range of microscopy equipment (AFM, STM, SEM, and optical) and nanoscale fabrication hardware.

Analytical Services Center

Our Analytical Services Center houses six NMR spectrometers, including one at 600 MHz, one at 500 MHz, four at 400 MHz (including a wide-bore instrument for imaging experiments) and a 300 MHz instrument dedicated to solid samples. All modern techniques (multidimensional, multinuclear, variable temperature) are available. Analytical Services also includes LCMS, GCMS, including accurate-mass capability on our Agilent ESI-TOF instrument. Analytical labs are fully staffed with professional spectrometrists.

College of Science -- Crystallography Laboratory

Our X-ray diffractometer is housed in the College of Science Crystallography Laboratory (VTX), which features a range of diffractometers and a capabilities such as ultra-low temperature (to 15 K), high pressure (to 10 GPa), and the ability to analyze small crystals and proteins.

Polymer Characterization Laboratory

The polymer characterization laboratory features GPC, TGA, and DSC, as well as mechanical and rheological testing instruments.

Surface Analysis Laboratory

The Surface Analysis Laboratory features XPS, Auger, and AFM instruments.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Analytical (4.0)

IELTS

General Test: (7.5)

This section offers brief synopses of the programmatic requirements for the M.S. and Ph.D. degrees in Chemistry at Virginia Tech. Applicants and current students are directed to our policies and procedures manual for the complete, detailed description of these requirements:

<http://www.chem.vt.edu/grad/grad-documents/grad-orange-book.pdf>The M.S. degree may be earned in one of two ways. The student may prepare and defend a Master's Thesis; alternatively there is a non-thesis M.S. option that is based exclusively on course work. The Thesis M.S. degree requires 20 credit hours of graduate course work, the presentation of one seminar, and the preparation and oral defense of the M.S. thesis. The non-thesis M.S. degree requires 24 credit hours of regular graduate course work plus 6 credit hours of report-based courses.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Analytical (4.0)

IELTS

General Test: (7.5)

This section offers brief synopses of the programmatic requirements for the M.S. and Ph.D. degrees in Chemistry at Virginia Tech. Applicants and current students are directed to our policies and procedures manual for the complete, detailed description of these requirements:

<http://www.chem.vt.edu/grad/grad-documents/grad-orange-book.pdf>Each doctoral student must complete a minimum of four graduate-level courses. The selection of courses depends on the student's research interests and are established in consultation with the student's Advisory Committee. Some additional courses may be required to ensure that the student has a broad Foundation of knowledge; these courses are determined by the student's performance on entrance examinations in Inorganic Chemistry, Organic Chemistry, Physical Chemistry, and Instrumental Analysis administered during Orientation Week. Each doctoral student also must complete two report courses; in the first enrollment (3rd semester of residence) a Literature Review is prepared, and in the second enrollment (6th semester of residence) an Original Research Proposal is prepared. Each doctoral student also must present two seminars and satisfy annual reporting and evaluation requirements as specified in the document linked above.

GRADUATE COURSES (CHEM)

CHEM 5004:

Orientation to Graduate Research

A survey of topics needed to meet high standards of safety, scholarship, and productivity in research-based chemistry graduate programs.

Graduate standing required.

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CHEM 5014 (CHE 5014) (MSE 5014):

Communication Skills and Methods of Presentation

Methods and style to make effective technical and nontechnic presentations including blackboard presentations, overhead presentations, slide presentations, and research posters. Video presentations with critiques.

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CHEM 5084:

Macromolecular Interfaces with Life Sciences Seminar

Experience in developing and presenting a technical seminar related to oxidative processes at the macromolecule-biomolecule interface. Tours and presentations at research facilities at regional industrial sites. Idea generation for the purpose of resolving technical questions and advancing research projects. Pre: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell & molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. Graduate standing required.

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CHEM 5094 (BMVS 5094):

Grant Writing and Ethics

A framework for writing clear, concise grant proposals in a team-oriented, multidisciplinary approach from concept development through submission to a funding agency. Potential ethical dilemmas that may arise in academic, industrial, or federal research settings will be discussed. Pre: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell & molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. (3H, 3C) Graduate standing required. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CHEM 5104:

Advanced Analytical Chemistry I

Discussion of theory and applications of separations and spectrometry in analytical chemistry. Topics include: GC, HPLC, Gel Permeation Chromatography, Electrophoresis, AAS, AES, AFS, lasers, flame, and plasma diagnostics. One year of physical chemistry required. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CHEM 5114:

Advanced Electrochemistry

Discussion of theory and application of chemical equilibrium, reaction rate methods, and electroanalytical methods in analytical chemistry. One year of physical chemistry required. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CHEM 5124:

Analytical Spectroscopy

Principles, instrumentation, and applications of atomic and molecular spectroscopy. Theoretical descriptions of electronic and ro-vibrational energy levels, transitions, and energy dynamics. Modern spectroscopic instrumentation and applications in quantitative analyses. Prerequisite or equivalent.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): CHEM 3616 (UG) OR CHEM 36616
Corequisite(s):

Instrument Design

Design, construction, and operating principles of analytical instrumentation. Topics will include major instrument components (vacuum, optical, charged-particle), instrument construction (spectrometers, chromatographs), electronic data acquisition, and computer data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5174:

Polymer Viscoelasticity

Constitutive models of linear viscoelastic materials, experimental aspects, polymer response to mechanical and electrical inputs, solid state NMR and microwave interactions with polymers, free volume theories, temperature and environmental effects on polymers, physical aging of glasses. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5384:

Oxidation at the Interface of Chemistry and Biology

An advanced survey of the chemistry and biochemistry associated with oxidation reactions and the relationship to positive and detrimental outcomes in synthetic and natural macromolecules and biological systems. Topics include free radical chemistry, reactive oxygen and nitrogen species in living systems, enzyme-catalyzed oxidations, oxidation of foods and materials, oxidative stress and health effects, chemistry of antioxidants. PRE: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell and molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5404:

Advanced Inorganic Chemistry

An advanced coverage of topics in inorganic chemistry: principles of bonding in compounds of the metals and non-metals, applications of group theory to bonding, ligand field theory, inorganic and organometallic reaction mechanisms. Required core course for chemistry graduate students. One semester of undergraduate inorganic chemistry, one year undergraduate physical chemistry required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5424 (SBIO 5424):

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHEM 2565 (UG) OR CHEM 2565), (CHEM 2566 (UG) OR CHEM 2566) OR CHEM 2514

Corequisite(s):

CHEM 5505:

Advanced Organic Chemistry

Structure, stereochemistry, and bonding in organic compounds and their effects on organic reactivity. Ionic reactions, free radical reactions, and concerted reactions will be discussed. One year of undergraduate organic chemistry required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5506:

Advanced Organic Chemistry

105 Structure, stereochemistry, and bonding in organic compounds and their

effects on organic reactivity. Ionic reactions, free radical reactions, and concerted reactions will be discussed. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5505 (UG) OR CHEM 5505

Corequisite(s):

CHEM 5524:

Molecular Structure Determination

Structure determination of organic compounds by spectroscopic methods, with an emphasis on mass spectrometry and nuclear magnetic resonance. Course will emphasize problem-solving skills. Includes hands-on instruction in nuclear magnetic resonance spectroscopy and other analytical spectroscopic methods. Partially duplicates 4524; students cannot receive credit for both 4524 and 5524.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CHEM 2536 (UG), (CHEM 3616 (UG) OR CHEM 4616 (UG)) OR CHEM 2536, (CHEM 3616 OR CHEM 4616)

Corequisite(s):

CHEM 5525 (GEOS 5535):

X-ray Crystallography

5525: Provides a thorough grounding in the principles of the crystalline state including lattices and symmetry, leading to the formal description of structures and surfaces and interpretation of published crystallographic data. 5526: Covers methods of single-crystal and powder X-ray diffraction for the determination of the atomic arrangement of atoms within crystalline materials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3504 OR CHEM 3615

Corequisite(s):

CHEM 5526:

X-RAY CRYSTALLOGRAPHY

5525: Provides a thorough grounding in the principles of the crystalline state including lattices and symmetry, leading to the formal description of structures and surfaces and interpretation of published crystallographic data. 5526: Covers methods of single-crystal and powder X-ray diffraction for the determination of the atomic arrangement of atoms

within crystalline materials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (GEOS 3504 (UG) OR CHEM 3615 (UG)) OR (GEOS 3504 OR CHEM 3615)

Corequisite(s):

CHEM 5535:

Synthetic Organic Chemistry

Modern synthetic methods and their applications to the preparation of various classes of organic compounds. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5505 (UG) OR CHEM 5505

Corequisite(s):

CHEM 5536:

Synthetic Organic Chemistry

Modern synthetic methods and their applications to the preparation of various classes of organic compounds. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5505 (UG) OR CHEM 5505

Corequisite(s):

CHEM 5644:

Colloid and Surface Chemistry

Characterization of interfaces including liquid/gas and liquid/liquid (spread monolayers) interfaces, nature of solid surfaces, gas/solid (thermodynamics), and liquid/solid (wetting, colloidal stability) interfaces. PRE: One year of physical chem or consent. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5654:

Adhesion Science

106 Introduction to basic principles of adhesion science from the areas of

mechanics, materials, and chemistry. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5664:

Chemical Kinetics

Phenomenological kinetics with emphasis on measurement techniques and the interpretation of kinetic data. Significance of rate laws, activation parameters for mechanisms, catalysis and fast reactions in gas and condensed phase are discussed. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5614 (UG) OR CHEM 5614

Corequisite(s):

CHEM 5704:

Synthesis and Reactions of Macromolecules

Advanced treatment of the kinetics, mechanisms, synthesis and reactions of macromolecules via step and chain processes. PRE: Second year grad standing in chemistry, chemical engineering, or consent. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5884:

Macromolecular Chemistry at the Biology Interface Laboratory

An advanced laboratory course that involves state-of-the-art experimental techniques with applications for data interpretation and presentation for future professionals at the polymer chemistry-biology interface. Team-oriented experiments will use traditional and emerging polymer chemistry techniques and applied biological methods, specifically those involving analysis of free radical and oxidative processes. PRE: CHEM/FST/BMVS 5384 or simultaneous enrollment in this course.

Credit Hour(s): 0 OR 2

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5894:

Final Examination

For non-thesis candidates who are required to register for their final examination and have completed their program of study. Not to be included in minimum hours required for degree.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5904:

Project and Report

A detailed written report on a current topic in chemistry or interdisciplinary areas involving chemistry. Non-thesis M.S. students in chemistry are required to complete 4 credit hours of CHEM 5904.

Graduate standing in chemistry required.

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CHEM 5914:

Literature Review and Research Plan

Preparation of a written review of a topical research area within chemistry or a closely allied interdisciplinary field. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5944:

Graduate Seminar

Recent advances in various fields of chemistry are covered by means of reports carefully prepared and presented by individual students, under direction of various members of chemistry faculty. Work of each student is judged not only by report he gives but also by an intelligent discussion

of reports presented by other students. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

CHEM 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CHEM 6164:

Current Topics in Analytical Chemistry

Special topics in frontier areas of analytical chemistry. Offered when appropriate.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHEM 5104 (UG), CHEM 5114 (UG)) OR (CHEM 5104, CHEM 5114)

Corequisite(s):

CHEM 6434:

Organometallic Chemistry

Chemistry and applications of organometallic and related compounds.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 6464:

Current Topics in Inorganic Chemistry

Special topics in frontier areas of inorganic chemistry. Offered when appropriate.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 6504:

Chemistry of Natural Products

The structures, biosyntheses, reactions, and biomimetic syntheses of natural products, with examples from each of the major classes of polyketides, shikimates, terpenoids, alkaloids, antibiotics, and marine natural products.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5506 (UG) OR CHEM 5506

Corequisite(s):

CHEM 6564:

Current Topics in Organic Chemistry

Special topics in frontier areas of organic chemistry. Offered when appropriate.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5506 (UG) OR CHEM 5506

Corequisite(s):

CHEM 6624:**Chemical Thermodynamics**

Rigorous application of the laws of thermodynamics to real fluids, solutions, chemical equilibria, and non-equilibrium processes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5614 (UG) OR CHEM 5614

Corequisite(s):

CHEM 6634:**Quantum Chemistry and Spectroscopy**

Study of basic quantum mechanics followed by some of its applications to chemistry and spectroscopy. Topics include: the variational method; perturbation theory; Hartree-Fock theory; the electronic structures of atoms and molecules; atomic spectra; and molecular rotational, vibrational, and electronic spectra. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5614 (UG) OR CHEM 5614

Corequisite(s):

CHEM 6664:**Current Topics in Physical Chemistry**

Special topics in frontier areas of physical chemistry. Offered when appropriate.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5614 (UG) OR CHEM 5614

Corequisite(s):

CHEM 6674:**Physical Chemistry of Polymers**

Quantitative treatment of polymer chemical composition, stereochemistry, molecular weight, topology, morphology, viscoelasticity, mechanical behavior. Offered every other year. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (CHEM 3615 (UG), CHEM 3616 (UG)) OR (CHEM 3615, CHEM 3616)

Corequisite(s):

CHEM 6904:**Generating Research Ideas**

Process of generating and evaluating novel research ideas in chemistry.

Pre: Graduate Standing.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 6914:**Original Research Proposal**

Preparation of a written original research proposal in chemistry or a closely related interdisciplinary field. Must have passed the Preliminary Oral Exam.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 5914

Corequisite(s):

CHEM 6984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHEM 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 20

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ECONOMICS

Nicolaus Tideman, Head

students who begin their studies, but are unable to complete the program.

Emeriti Faculty: Amoz Kats;

Professors: Richard Ashley; Hans Haller; Djavad Salehi-Isfahani; Aris Spanos;
Thorwald Tideman;

Associate Professors: Sheryl Ball; Richard Cothren;

Assistant Professors: Eric Bahel; Adam Dominiak; Suqin Ge; Joao Macieira;
Kwok Tsang; Zhou Yang;

Research Faculty: Guo Li;

Instructors: Gebremeskel Gebremariam; Steven Trost;

Wilson Schmidt Professor: Aris Spanos;

General Contact: astanfor@vt.edu

Graduate Program Director: byront@vt.edu

Graduate Program: <http://www.econ.vt.edu/graduate/graduate.htm>

Student Handbook: <http://www.aaec.vt.edu/aaec/StudentPlanningGuide.pdf>

The Virginia Tech Economics program was established September 1, 1961. The program has awarded more than 200 Ph.D.s in economics since its inception. Our graduates now work as successful professionals worldwide in academia, business and government. Since 2000, the program has been administered jointly by the Department of Economics and Agricultural and Applied Economics.

SPECIAL FACILITIES

The Department

Students on assistantship are allocated office space in the department. All students have access to computers in their office with internet access. The department has an experimental economics lab in 2088 Derring Hall.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (80.0)

GRE

General Test: Quantitative (600.0)

Ph.D. must complete 90 total credit hours of work, consisting of 24 credit hours of core requirements, 21 credit hours of field courses, 30 credit hours of research & dissertation, and an additional 15 credit hours of research & dissertation or other Graduate level courses with the permission of the Graduate Director. The Economics Department does not offer a free standing terminal master's program. The M.A. degree in Economics is intended to serve advanced VT undergraduate students who participate in the 5th year B.S./M.A. program and those Ph.D.

GRADUATE COURSES (ECON)

ECON 5005:

Prices, Markets, and Resource Allocation

This sequence, which is part of the core curriculum in the Economics Ph.D program, covers fundamental concepts at the foundation of modern microeconomic theory. The sequence relies heavily on calculus and other mathematical tools. 5005: noncooperative game theory, competitive and non-competitive markets, theory of the firm. 5006: consumer theory, general equilibrium and welfare economics, uncertainty and asymmetric information. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 5006:

Prices, Markets, and Resource Allocation

This sequence, which is part of the core curriculum in the Economics Ph.D program, covers fundamental concepts at the foundation of modern microeconomic theory. The sequence relies heavily on calculus and other mathematical tools. 5005: noncooperative game theory, competitive and non-competitive markets, theory of the firm. 5006: consumer theory, general equilibrium and welfare economics, uncertainty and asymmetric information. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5005 (UG) OR ECON 5005

Corequisite(s):

ECON 5015:

Theory of Money, Income, Employment, and the Price Level

Part of core curriculum in the Econ Phd program providing an intensive treatment of modern macroeconomic and monetary theory. The course uses mathematical tools and analytic concepts. National income accounts; effective demand; neoclassical and Keynesian theories of capital and interest; supply and demand in money securities markets; introduction to macroeconomic dynamics; rational expectations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): null null

ECON 5016:

Theory of Money, Income, Employment, and the Price Level

Part of core curriculum in the Econ PhD program providing an intensive treatment of modern macroeconomic and monetary theory. The course uses mathematical tools and analytic concepts. National income accounts; effective demand; neoclassical and Keynesian theories of capital and interest; supply and demand in money securities markets; introduction to macroeconomic dynamics; rational expectations. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5015 (UG) OR ECON 5015

Corequisite(s):

ECON 5124:

Mathematical Methods in Economics

Extensive treatment of new techniques for economic modeling. Review of linear algebra and calculus; static optimization, with Lagrangian and Kuhn-Tucker methods; differential and difference equations; dynamic optimization, with calculus of variations, optimal control and dynamic programming. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 5125 (AAEC 5125):

Empirical Research Methods in Economics

Extensive treatment of new techniques for economic modeling. 5125: Probability and statistical inference, linear regression and related dynamic models, specification, estimation, misspecification, respecification, identification. 5126: Simultaneous equations, dynamic systems, time series, limited dependent variable models. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 5126 (AAEC 5126):

Empirical Research Methods in Economics

Extensive treatment of new techniques for economic modeling. 5125: Probability and statistical inference, linear regression and related dynamic models, specification, estimation, misspecification, respecification, identification. 5126: Simultaneous equations, dynamic systems, time series, limited dependent variable models. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5125 (UG) OR ECON 5125

Corequisite(s):

ECON 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 5945:

Econometric Theory and Practice

An intensive coverage of the most important techniques of econometric estimation and hypothesis testing, addressing the use of both cross-section and time series data. A core sequence in the MA program in both locations. Prerequisite to the research-thesis seminar in Northern Virginia. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 2115 (UG) OR ECON 2116 (UG) OR ECON 2005 (UG) OR ECON 2006 (UG) OR ECON 2125 (UG) OR ECON 2126 (UG) OR ECON 2025H (UG) OR ECON 2026H (UG) OR ECON 2115 OR ECON 2116 OR ECON 2005 OR ECON 2006 OR ECON 2125 OR ECON 2126 OR ECON 2025H OR ECON 2026H

Corequisite(s):

ECON 5946 (AAEC 5946):

Econometric Theory and Practice

An intensive coverage of the most important techniques of econometric estimation and hypothesis testing, addressing the use of both cross-

section and time series data. A core sequence in the MA program in both locations. Prerequisite to the research-thesis seminar in Northern Virginia. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 2115 (UG) OR ECON 2116 (UG) OR ECON 2115 OR ECON 2116

Corequisite(s):

ECON 5964:

Experimental Economics

Laboratory techniques are valuable for answering research questions which defy traditional empirical analysis due to lack of field data. Examples include proposed regulations, new market designs and tests of theory. The goal of this course is two-fold: to develop skills in experimental methods appropriate for economics and related fields and to familiarize students with the results of experimental tests of economic theory. Requirement: Graduate or honors undergraduate, major standing, and permission of the departmental director of graduate study or course instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ECON 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ECON 6004:

Strategic Behavior

Emphasizes strategic behavior in the presence of multiple decision makers. Game theory deals with strategic interaction and provides the formal framework to describe and analyze situations with conflicting interests--as well as situations with both common and conflicting interests. Proof of applicability is provided by means of numerical examples and real life cases, e.g., bargaining, contract theory, economic policy games, and voting. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECON 5005 (UG), ECON 5006 (UG)) OR (ECON 5005, ECON 5006)

Corequisite(s):

ECON 6024:

Advanced Topics in Econometrics Theory

This course assumes a basic understanding of multiple regression and simultaneous equations modeling and introduces students to advanced econometric techniques commonly used in empirical work. These techniques include linear time series modeling in the time domain, discrete choice models, and panel data methods. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5126 (UG) OR ECON 5126

Corequisite(s):

ECON 6044:

Collective Choice

Analysis of decision-making processes in committees, clubs, legislatures, and electorates.

Credit Hour(s): 4

Lecture Hour(s): 4

112 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECON 5005 (UG), ECON 5006 (UG)) OR (ECON 5005, ECON 5006)

Corequisite(s):

ECON 6054:

Development Economics

A modern approach to economics of growth and development for graduate students in economics and related disciplines. Topics include sources of growth; neo-classical, endogenous, and dualistic theories of growth; households economics and human capital accumulation; economics of population; and consequences of imperfect market for land, labor and capital.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECON 3104 (UG), ECON 3204 (UG)) OR (ECON 3104, ECON 3204)

Corequisite(s):

ECON 6104:

Labor Economics

Labor demand and supply, investment in human capital, discrimination in the labor market, and the theory of equalizing wage differentials; search and unemployment, unions, and income distribution. I

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5005 (UG) OR ECON 5005

Corequisite(s):

ECON 6204:

Public Economics

This course describes the theory of government expenditures, stressing market failure as the rationale for government activity. The course describes the normative outcome achieved by a benevolent government, and the positive outcome achieved under rules of collective choice. Tax policy for different levels of government and selected topics in state and local public finance are also addressed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECON 5005 (UG), ECON 5006 (UG)) OR (ECON 5005, ECON 5006)

Corequisite(s):

ECON 6304:

International Trade and Finance

Core models in international trade and finance; current topics in international economics. Ricardian, Heckscher-Ohlin-Samuelson, Dynamic imperfect competition trade theories; Political economy of trade; Trade policy, Factor mobility, Uncertainty, and Intra-industry trade. Mundell-Fleming, Monetary, Real- and Imperfect competition- Micro-foundations theories of international macroeconomics; exchange rate determination; and capital markets. Extensions to monetary and fiscal policy, economic growth, and external debt analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECON 5005, ECON 5015) OR (ECON 5005 (UG), ECON 5015 (UG))

Corequisite(s):

ECON 6404:

Industry Structure

Effects of industry structure on price and non-price behavior of firms, on market equilibrium, and on economic welfare. Problems of oligopolistic industries and analysis of government policies (regulation, anti-trust). I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5005 (UG) OR ECON 5005

Corequisite(s):

ECON 6454:

Dynamic Analysis

Advanced treatment of the analysis and optimization of dynamic economic systems using mathematical tools and analytic concepts. Topics include: optimal control theory; dynamic programming; economics of resource allocation over time, and stochastic optimization models. Permission of course instructor required. Alternate years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AAEC 5025 (UG) OR AAEC 5025, AAEC 5124 (UG) OR AAEC 5124

Corequisite(s):

ECON 6554:**Panel Data Econometrics**

Introduction to the major panel data techniques and modeling ideas currently employed (e.g., dynamic panel, panel for discrete choice model, treatment effect and program evaluations etc.), including both statistical theory derivations and practical applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (AAEC 5125 OR ECON 5125), AAEC 5126

Corequisite(s):

ECON 6604:**Advanced Methods in Applied Microeconomics**

Specification and estimation of static, dynamic oligopoly models, application of these models to the study of entry and market structure, vertical relationships, and collusion. Empirical application of auction models to economic development and to public finance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5005

Corequisite(s):

ECON 6614:**Philosophical Foundations of Econometrics**

The philosophical and methodological problems underlying econometric modeling and inference. Topics include the distinction between statistical and substantive significance, the proper interpretation of inference p-values, data mining, and other issues related to reliable inference and learning from data.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5125

Corequisite(s):

ECON 6994:**Research Seminar**

Review and discussion of current research in economics by students, faculty members, and guest speakers. This course may be repeated for a maximum of 6 credits. Students are required to have Doctoral Standing in Economics.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECON 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

GEOSCIENCES

Nancy Ross, Head

Emeriti Faculty: Gerald Gibbs; James Read; James Rimstidt; J Snoke;

Professors: Robert Bodnar; Patricia Dove; Kenneth Eriksson; Michael Hochella;

John Hole; Scott King; Richard Law; Nancy Ross; Madeline Schreiber; James

Spotila; Robert Tracy; Shuhai Xiao;

Associate Professors: Thomas Burbey; Robert Weiss; Ying Zhou;

Assistant Professors: Barbara Bekken; Mark Caddick; Esteban Gazel; Benjamin

Gill; Frederick Michel; Sterling Nesbitt; Brian Romans;

Adjunct Professors: Ross Angel; James Beard; Benedetto De Vivo; Alton Dooley;

Nicholas Fraser; William Henika; David Houseknecht; Jerry Hunter; Michal

Kowalewski; James Schiffbauer; Lauck Ward; Chester Watts;

University Distinguished Professor: Robert Bodnar; Patricia Dove; Gerald

Gibbs; Michael Hochella;

Associate Professor of Practice: John Chermak;

Research Associate Professors: Martin Chapman;

Research Professors: Robert Lowell;

Advanced Instructors: Neil Johnson;

Research Scientists: Luca Fedele; Esther Schwarzenbach; Michelle Stocker;

Graduate Contact: clowe@vt.edu

Department Site: <http://www.geos.vt.edu>

Virginia Tech's Department of Geosciences focuses on research, education and outreach dealing with the nature of the earth. We offer the MS and PhD degree programs at the Blacksburg campus. Our students and faculty investigate earth processes at scales that range from atomic to planetary. We encourage interdisciplinary approaches to research in the geosciences, both within the department and through interdepartmental programs. More details about the department, faculty, and research programs can be found at <http://www.geos.vt.edu/>. We

encourage prospective students to fill out a pre-application survey and to contact individual faculty to explore research opportunities.

General Test: (6.5)

SPECIAL FACILITIES

The Department of Geosciences is currently housed in Derring Hall. Our Derring laboratory and research space includes (see <http://www.geos.vt.edu/research/facilities.php> for more details): Aqueous Geochemistry Laboratory Biogeochemistry of Earth Processes (BGEP) Laboratory Chemical Hydrogeology Lab Electron Beam Laboratory (Electron Microprobe and SEM) Exploration Geophysics Field Equipment Laboratory Fluids Research Laboratory Geothermal Database Hydrothermal Synthesis and Experiment Laboratories Laser-Ablation ICPMS Laboratory Light Stable Isotope Laboratory Micropaleontology Laboratory Nanogeochemistry, Mineral Surface Geochemistry, and Biogeochemistry Laboratory Optical Microscopy and Digital Photomicrography Laboratory Paleobiology Laboratory Paleocology Laboratory Physical Hydrogeology Laboratory Radiogenic Helium Laboratory Sample Preparation Clean Laboratory Sedimentology and Stratigraphy Laboratory Seismological Observatory Structure Laboratory The John K. Costain Geophysics Computing Facility Vertebrate Paleontology Laboratory Vibrational Spectroscopy Laboratory X-ray Diffractometer Laboratory X-ray Fluorescence Laboratory Cameca IMS-7F-Geo Secondary Ion Mass Spectrometer Laboratory, Dual-Beam FIB Facility, and EBSD-equipped SEMs in the Nanoscale Characterization and Fabrication Laboratory in the Institute for Critical Technology and Applied Science (<http://www.ictas.vt.edu/ncfl/index.html>)

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (80.0)

GRE

General Test: Verbal (550.0), Quantitative (650.0), Analytical (4.5)

IELTS

General Test: (6.5)

The M.S. student must pass a minimum of 30 credit hours, at least 20 of which must be taken as coursework, and at least 6 must be research credits. The final exam for the M.S. degree is a defense of the thesis. Virginia Tech will accept IELTS scores of 6.5 or higher in lieu of the TOEFL.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (80.0)

GRE

General Test: Verbal (550.0), Quantitative (650.0), Analytical (4.5)

IELTS

Ph.D. students must pass a minimum of 90 credit hours, at least 30 of which must be taken as coursework, and at least 6 must be research credits. The department does not give a standardized qualifying exam, but Ph.D. students must take a preliminary exam. The Ph.D. advisory committee shall have responsibility for the make-up and administration of the exam. The exam shall include both an oral and a written portion. Regulations that apply for the exam are: (1) the examination must be taken at least six months before the thesis/dissertation defense, and (2) at least 24 hours of coursework and/or research must remain to be taken at the time of the examination, including work for which the student is currently enrolled. It is recommended that the student meet with his/her advisory committee prior to preparing the exam to discuss the nature of the exam and the evaluation process. The final exam for the Ph.D. degree is a defense of the dissertation. Virginia Tech will accept IELTS scores of 6.5 or higher in lieu of the TOEFL.

GRADUATE COURSES (GEOS)

GEOS 5004:

Analytical Geosciences

Analytical techniques used in modern geosciences, including practical training in acquisition and processing of geological, geophysical, geochemical, and geobiological data. Topics include strategies of data acquisition and processing applied in geosciences, shape and size analysis of physical objects (fossils, clasts, etc.) and digital images (maps, thin sections, etc.), evaluation of time or space series, statistical analyses and parameter estimation and inversion of geoscientific data, and data-constrained numerical modeling of geological patterns and processes. Graduate standing required.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5014:

Earth System History

Study of the evolution of the atmosphere, hydrosphere, biosphere, and geosphere. Emphasis will be given to the interactions among these components of the Earth system and how these interactions have shaped the history of the Earth.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3204, GEOS 3604

Corequisite(s):

GEOS 5084G:

Intermediate Geographic Information Systems

Use of automated systems for geographic data collection, digitization, storage, display and analysis in graduate research. Basic data flow in GIS applications. Overview of GIS applications. Developing research methodology using GIS. Group projects to develop proficiency in the use of current GIS software. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5114:

Theoretical Seismology

Vibrations and waves, principle of the seismograph, elastic waves in unbounded media, and body and surface waves in a half-space and a layered half-space. Seismic ray theory for spherical media. Consent required. Alternate years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4564, ESM 5014

Corequisite(s):

GEOS 5124:

Geodynamics

Observations leading to the development of plate tectonics. Kinematics of plates on a sphere. Heat flow, mantle convection and viscous flow applied to solid planetary bodies. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5134:

Dynamics of Planetary Surface and Interiors

Structure and composition of the solar system as a constraint on planetary composition. Processes that shape and alter the surfaces and interiors of planets, moons, and asteroids including tectonics, volcanism, impact cratering, regolith formation, mass movement, and weathering.

Effect of gravity, heat, pressure, and internal deformation on planets, moons, and asteroids. Derivation of mathematical models to represent surficial and internal deformation processes. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

GEOS 5144 (MATH 5144):

Inverse Theory and Geoscience Applications

Overview of inverse theory, utilizing geophysical examples to illustrate the concepts of model construction, parameter estimation, resolution, and non-uniqueness. Emphasis is on the linear problem, concluding with an overview of nonlinear inversion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 2214, MATH 2224

Corequisite(s):

GEOS 5154:

Strong-Motion Seismology and Seismic Hazard Analysis

Introduction to the generation, propagation, measurement and prediction of strong ground motion from earthquakes, focusing on topics of importance to modern earthquake engineering. Effects of finite fault rupture, source directivity and Earth structure on the propagation of seismic waves; methods for developing ground motion time series for scenario earthquakes, statistical models of the earthquake recurrence process; probabilistic seismic hazard analysis. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 4154 (UG), MATH 4564 (UG), STAT 3005 (UG)

Corequisite(s):

GEOS 5204:

Terrigenous Depositional Systems

Bedforms and primary sedimentary structures, secondary sedimentary structures including trace fossils, facies, facies sequences, facies models, analysis of Holocene sedimentary environments, and paleoenvironmental interpretation of ancient sedimentary rocks, sedimentation and tectonics. Alternate years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3204

Corequisite(s):

GEOS 5214:

Carbonate Depositional Systems and Sequence Stratigraphy

Classroom, laboratory and field examination of the temporal and spatial makeup and controls on mineralogy and constituent composition of sedimentary carbonates, sequence stratigraphy of carbonate platforms, paleoclimatic significance of carbonates succession. Introduction to porosity evolution and cementation of carbonates in marine, meteoric and burial realms.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): GEOS 3204

Corequisite(s):

GEOS 5224:

Clastic Petrography and Diagenesis

Formation of terrigenous particles by weathering, clay mineralogy, clay diagenesis, tectonic control on framework grain composition, quartz arenites and silicretes, feldspathic sandstones, lithic sandstones, greywackes, and controls on sandstone diagenesis. Alternate years.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): GEOS 3504, GEOS 3204, GEOL 4504

Corequisite(s):

GEOS 5254G:

Advanced Earthquake Seismology

Seismicity and its causes in the context of plate tectonics; determination of earthquake location and mechanisms; seismogram (time series) analysis; theory of seismometers; hazard potential; wave propagation; use of earthquakes in determining earth structure. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5354G:

Advanced 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. Field project and report. Review of current research literature.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5374:

Quantitative Paleobiology

Use of quantitative methods in paleontology. Analysis of paleontological data. Modelling the macroevolutionary process. The role of quantification in establishing a rigorous science of paleontology. Consent required.

Alternate years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3604

Corequisite(s): STAT 5605, STAT 5606

GEOS 5384:

Morphometrics

Study of shape and size in fossil and modern organisms with strong focus on quantitative methods and digital image analysis. Covers analytical methods (multivariate methods, Fourier analysis, geometric morphometrics), image processing, and software training (SAS, SAS/IML, and Imaging Software).

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): STAT 5004, GEOS 5374

Corequisite(s):

GEOS 5404G:

Graduate Advanced Structure

(experimental and tectonic) and analysis of the geometrical patterns produced. Graduate students will undertake a more advanced independent research project. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5424:

Structural Petrology

Examination of the processes by which rocks deform due to tectonic stresses, and recognition and interpretation of the microstructures that record these processes. Consent required. Alternate years. II

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): GEOS 3504, GEOS 3704

Corequisite(s):

GEOS 5525:

Electron Microprobe

Theory and practice of qualitative and quantitative elemental microanalysis using electron-excited x-rays. Consent required. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5526:

Electron Microprobe

Theory and practice of qualitative and quantitative elemental microanalysis using electron-excited x-rays. Consent required. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5535 (CHEM 5525):

X-Ray Crystallography

5535: Provides a thorough grounding in the principles of the crystalline

state including lattices and symmetry, leading to the formal description of structures and surfaces and the interpretation of published crystallographic data. 5536: Covers methods of single-crystal and powder X-ray diffraction for the determination of the atomic arrangement of atoms within crystalline materials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3504 OR CHEM 3615

Corequisite(s):

GEOS 5536:

X-RAY CRYSTALLOGRAPHY

5535: Provides a thorough grounding in the principles of the crystalline state including lattices and symmetry, leading to the formal description of structures and surfaces and interpretation of published crystallographic data. 5536: Covers methods of single-crystal and powder X-ray diffraction for the determination of the atomic arrangement of atoms within crystalline materials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3504 OR CHEM 3615

Corequisite(s):

GEOS 5594 (CEE 5594):

Geological Engineering

Mechanical and hydraulic properties of rock masses; analysis and design of rock foundations, slopes, tunnels, and other forms of civil infrastructure; rock reinforcement. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5634G:

Advanced 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 using fundamental principles to understand natural systems and solve practical problems in environmental

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5704:

Geochemical Thermodynamics

Fundamentals of chemical thermodynamics as applied to earth materials (solid, fluid and gaseous) over wide ranges of pressure and temperature.

Derivation of thermodynamic functions from the three laws of thermodynamics. The phase rule, phase equilibria, and Schreinemaker's analysis. Comparison of the behavior of real and ideal systems.

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3504, MATH 2224, CHEM 1036

Corequisite(s):

GEOS 5714G:

Advanced 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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5744:

Fluid Inclusions Techniques

The study of fluid inclusions in rocks and minerals from sedimentary, metamorphic, igneous, and ore-forming environments. Basic fluid inclusion principles and techniques and characteristics of inclusions from these various geologic environments will be described. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5754:

Fluids in the Earth's Crust

The physical and chemical properties of various fluids of geologic interest and the interaction of these fluids with minerals, rocks, and melts in the earth's crust are considered. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5804:

Quantitative Hydrogeology

Rigorous mathematical and physical concepts of fluid flow in porous geological media. The course will focus on the mechanics of groundwater flow in one, two, and three spatial dimensions. Boundary conditions and analytical solutions to subsurface and vadose-zone flow problems will be explored and solved analytically. The mechanics of horizontal and vertical deformation of aquifers due to applied pumping stress will be taught from first principles. Includes problems dealing with steady and transient groundwater flow, Biot's equations and three-dimensional consolidation theory.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOL 4114, (MATH 2214 OR MATH 2514)

Corequisite(s):

GEOS 5804G:

Advanced Groundwater Hydrology

Physical principles of groundwater flow, including application of analytical solutions to real-world problems. Well hydraulics. Geologic controls on groundwater flow. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

Numerical Modeling of Groundwater

Theory and practice of numerical techniques are developed and applied to fluid flow and transport in ground-water flow systems. Governing equations are formulated using FD and FE techniques with appropriate BC's and IC's. Additional topics include: model conceptualization and grid design in multidimensional systems; practical applications of numerical models including calibration, validation, and prediction; concepts and techniques of advective transport using particle tracking and dispersive transport. Introduction to MODFLOW, MODPATH, MT3D, and others.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOL 4114 OR CEE 4314

Corequisite(s):

GEOS 5834:

Chemical Hydrogeology

Study of solute transport in geologic systems. Focus on processes of advection, dispersion, mineral dissolution and precipitation, chemical reactions and microbially-mediated reactions. Includes use of hydrogeochemical models to simulate chemical transport in geologic systems. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 4804, (CEE 4314 OR CEE 4594 OR CSES 4594)

Corequisite(s):

GEOS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

GEOS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

GEOS 6104:

Advanced Topics in Geophysics

Advanced analysis of one or more topics of geophysics using the most recent techniques, interpretations, and data. Can be taken up to three times provided the subject material is different. Consent required.

Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 6194:

Seminar in Geophysics

Critical review of recent published works on selected topics in geophysics. Consent of instructor required. Alternate years. May be repeated for a maximum of 8 credits.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 5114, GEOS 5134

Corequisite(s):

GEOS 6204:

Advanced Topics in Sedimentology

Advanced analysis of one or more topics in sedimentology using the most recent techniques, interpretations, and data. Can be taken up to three times provided the subject material is different. Consent required.

Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

120 Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 6304:

Advanced Topics in Paleontology

Advanced analysis of one or more topics in paleontology using the most recent techniques, interpretations, and data. Can be taken up to three times provided the subject material is different. Consent required.

Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 6404:

Advanced Topics in Structure/Tectonics

Current ideas and research problems in structural geology and tectonics.

Can be taken up to three times provided the subject material is different.

Consent required. Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 3404

Corequisite(s):

GEOS 6504:

Advanced Topics in Mineralogy

Current research in the major mineral groups subdivided by crystallographic, crystal chemical, or petrogenetic affinities. May be repeated up to three times. Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOS 5504

Corequisite(s):

GEOS 6604:

Advanced Topics in Geochemistry

Advanced analysis of one or more topics of geochemistry using the most recent techniques, interpretations, and data. Can be taken up to three times provided the subject material is different. Consent required.

Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 6704:

Advanced Topics in Petrology

Advanced analysis of one or more topics of petrology using the most recent techniques, interpretations, and data. Can be taken up to three times provided the subject material is different. Consent required.

Alternate years.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 6804:

Advanced Topics in Hydrogeology

Advanced analysis of one or more topics of hydrogeology. Can be taken up to three times provided the subject material is different. Pre: Consent of instructor.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOS 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MATHEMATICS

Peter Haskell, Head

Professors: Slimane Adjerid; Joseph Ball; Christopher Beattie; Jeffrey Borggaard;

121 Ezra Brown; John Burns; Martin Day; Eric De Sturler; Mark Embree; William Floyd;

George Hagedorn; Peter Haskell; Terry Herdman; Jong Kim; Martin Klaus; Werner Kohler; Tao Lin; Peter Linnell; Carl Prather; Frank Quinn; Michael Renardy; Yuriko Renardy; Robert Rogers; John Rossi; David Russell; Mark Shimozono; Shu Ming Sun; James Turner;

Associate Professors: Alexander Elgart; Serkan Gugercin; Traian Iliescu; Nicholas Loehr; Henning Mortveit; Anderson Norton; Peter Wapperom; Lizette Zietsman;

Assistant Professors: Julianne Chung; Matthias Chung; Mihaela Ciupe; Nathan Glatt-Holtz; Estrella Johnson; Constantin Mihalcea; Megan Wawro; Pengtao Yue;

Affiliated Faculty: Daniel Orr; Omer San;

Alumni Distinguished Professor: Ezra Brown;

Hatcher Professor of Mathematics: John Burns;

Class of 1950 Professor: Michael Renardy; Yuriko Renardy;

General Contact: info@math.vt.edu

Graduate Site: <http://www.math.vt.edu/grProspective.php>

Student Handbook: <http://www.math.vt.edu/grPolicies.pdf>

The Department of Mathematics offers programs leading to M.S. and PhD degrees. Both traditional and interdisciplinary options are available for the M.S. degree. Details about the M.S. and PhD degree options can be found in our graduate program policies document available at <http://www.math.vt.edu/grPolicies.pdf>. The Department has internationally recognized excellence in the areas of algebra and combinatorics, algebraic geometry and topology, computational science, continuous and discrete dynamical systems, control theory and optimization, fluid dynamics, math education, mathematical biology and mathematical physics, number theory, numerical analysis, and partial differential equations. This research is supported by collaborations with researchers across Virginia Tech either in other departments or in various centers and institutes. These include, among others, the Center for Mathematical Computation (CMC), the Interdisciplinary Center for Applied Mathematics (a University research center), and the Virginia Bioinformatics Institute. Please visit the Department of Mathematics at <http://www.math.vt.edu> for more information.

SPECIAL FACILITIES

Students on assistantship are allocated office space in the department and offices are made available to those students not on assistantship as space allows. All students have access to a well-equipped graduate computer laboratory and students may use a departmental cluster.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

The M.S. degree is designed to be completed in two years of graduate study. M.S. degrees are available under thesis and non-thesis options. Under the thesis option the student writes and defends a Master's Thesis under the direction of a faculty member. The time spent preparing the thesis is represented by 6 to 9 hours of MATH 5994 (Research and Thesis) among the required courses. The hour and course requirements for each of these degrees are detailed in "Policies and Degree Requirements" at <http://www.math.vt.edu/grPolicies.pdf>. The department also offers a special interdisciplinary plan for either the thesis or non-thesis M.S. degrees. This plan is intended for students having clearly defined, interdisciplinary career goals. Additional flexibility in the formal requirements allows the student's advisory committee to customize a Plan of study to the student's goals. It must be emphasized that the interdisciplinary plan is intended only for students who enter the graduate program with specific, interdisciplinary career objectives. The student desiring studies under this plan needs to take the initiative to develop an appropriate Plan of study at the very outset of his/her graduate studies. Hour Requirements: For any of the degree options, the student's Plan of Study must show 30 hours. The courses which make up these 30 hours must meet the constraints indicated in "Policies and Degree Requirements" at <http://www.math.vt.edu/grPolicies.pdf>. (Transfer credit may be used for up to 50% of coursework numbered 5000 and higher, subject to the advisory committee's approval and Graduate School guidelines.)

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

The PhD requires the completion of 90 hours, of which between 30 and 60 must be MATH 7994 (Research and Dissertation). At least 27 hours must be mathematics courses (excluding Research and Dissertation) numbered 5000 or higher. Up to 42 hours of transfer credit can be used, subject to the advisory committee's approval and Graduate School guidelines. Courses used toward the M.S. in mathematics may be used toward the PhD as well. More information about the specific requirements for the PhD can be found in "Policies and Degree Requirements" at <http://www.math.vt.edu/grPolicies.pdf>.

GRADUATE COURSES (MATH)

MATH 5114:

Specialized Topics in Algebra

Various graduate level topics in algebra such as field theory, non-commutative ring theory, group representation theory, Lie algebras. May be taken for credit more than once with departmental permission. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): MATH 4124
Corequisite(s):

MATH 5125:

Abstract Algebra

Groups, rings and ideals, modules, brief introduction to homological algebra. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4124

Corequisite(s):

MATH 5126:

Abstract Algebra

Groups, rings and ideals, modules, brief introduction to homological algebra. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4124, MATH 5125

Corequisite(s):

MATH 5135:

Topics in Number Theory

Advanced topics in number theory such as algebraic number theory, analytic number theory, or theory of quadratic forms.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4124, MATH 4234

Corequisite(s):

MATH 5144 (GEOS 5144):

Inverse Theory and Geoscience Applications

Overview of inverse theory, utilizing geophysical examples to illustrate the concepts of model construction, parameter estimation, resolution, and non-uniqueness. Emphasis is on the linear problem, concluding with an overview of nonlinear inversion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 2214, MATH 2224

Corequisite(s):

MATH 5214:

Specialized Topics in Analysis

Various graduate level topics in analysis for graduate students in mathematics and qualified students in other areas. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5225:

Real Analysis

Basic set theoretic and topological notions, fundamental theorems of measure and integration, differentiation, applications to linear analysis.

I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4226

Corequisite(s):

MATH 5226:

Real Analysis

Basic set theoretic and topological notions, fundamental theorems of measure and integration, differentiation, applications to linear analysis.

I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4226, MATH 5225

Corequisite(s):

MATH 5235:

Complex Analysis

Holomorphic functions, complex integration and residues, series expansions, normal families and the Riemann mapping theorem, entire functions, power series in the unit disk. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

123 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 3224 OR MATH 4225

Corequisite(s):

MATH 5236:

Complex Analysis

Holomorphic functions, complex integration and residues, series expansions, normal families and the Riemann mapping theorem, entire functions, power series in the unit disk. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 3224 OR MATH 4225, MATH 5235

Corequisite(s):

MATH 5245:

Ordinary Differential Equations

Existence theorems, linear theory, stability theory, periodic solutions, Poincare-Bendixon theory, boundary-value problems, functional differential equations. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4225

Corequisite(s):

MATH 5246:

Ordinary Differential Equations

Existence theorems, linear theory, stability theory, periodic solutions, Poincare-Bendixon theory, boundary-value problems, functional differential equations. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4225, MATH 5245

Corequisite(s):

MATH 5344:

Specialized Topics in Topology and Geometry

Various graduate level topics in topology and geometry. May be taken for credit more than once with department consent. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4324

Corequisite(s):

MATH 5415:

Specialized Topics in Applied Math

Various graduate level topics in applied mathematics for graduate students in mathematics and qualified students in other areas. May be taken for credit more than once with department consent. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5416:

Specialized Topics in Applied Math

Various graduate level topics in applied mathematics for graduate students in mathematics and qualified students in other areas. May be taken for credit more than once with department consent. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5425:

Applied Partial Differential Equations

Partial differential equations of first and second order, hyperbolic equations, elliptic equations and Green's functions, parabolic equations, canonic forms, application to physics and engineering. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4426 OR MATH 4564

Corequisite(s):

MATH 5426:

Applied Partial Differential Equations

Partial differential equations of first and second order, hyperbolic equations, elliptic equations and Green's functions, parabolic equations, canonic forms, application to physics and engineering. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4426 OR MATH 4564, MATH 5425

Corequisite(s):

MATH 5435:

Principles and Techniques of Applied Mathematics

Methods and techniques for obtaining approximate solutions to differential and integral equations that are not solvable exactly.

Asymptotic and perturbation analysis, complex integration. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5444:

Numerical Methods for Ordinary Differential Equations

Computational procedures for ordinary differential equations including Runge-Kutta methods, variable-step Runge-Kutta methods, predictor-corrector methods, applications to two-point boundary-value problems and parameter estimation. Error control, relative and absolute stability, methods for stiff equations; with computer assignments. Senior standing in engineering, science, or mathematics, and some programming ability required. IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5454:

Graph Theory

Graphs, trees, connectivity, Euler tours, matching, independent sets and cliques, planar graphs, directed graphs. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5464:

Combinatorics

Counting problems, generating functions, recurrence relations, principle of inclusion and exclusion, experimental designs. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5465 (CS 5465):

Numerical Analysis

A survey of the construction, analysis, and implementation of numerical algorithms in linear algebra, nonlinear equations and optimization, approximation by polynomials, quadrature, and ordinary differential equations. High-level programming language required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4525

Corequisite(s):

MATH 5466 (CS 5466):

Numerical Analysis

A survey of the construction, analysis, and implementation of numerical algorithms in linear algebra, nonlinear equations and optimization, approximation by polynomials, quadrature, and ordinary differential equations. High-level programming language required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4525, MATH 5465

Corequisite(s):

MATH 5474 (CS 5474):

Finite Difference Methods for Partial Differential Equations

Finite difference methods for initial and boundary value problems for partial differential equations. Consistency, stability, convergence, dispersion, and dissipation. Methods for linear and nonlinear elliptic and parabolic equations, first- and second-order hyperbolic equations, and nonlinear conservation laws. High-level programming language required. I

I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 3414, MATH 4525

Corequisite(s):

MATH 5484 (CS 5484):

Finite Element Methods for Partial Differential Equations

Weak formulations of boundary-value problems for elliptic partial differential equations. Finite element spaces. Approximation theory for finite element spaces. Error estimates. Effects of numerical integration and curved boundaries. Nonconforming methods. Concrete examples of the application of the finite element method. Efficient implementation strategies. Time dependent problems. High-level programming language required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 3414, MATH 4525

Corequisite(s):

MATH 5485 (CS 5485):

Numerical Analysis and Software

Presentation and analysis of numerical methods for solving common mathematical and physical problems. Methods of solving large sparse linear systems of equations, algebraic eigenvalue problems, and linear least squares problems. Numerical algorithms for solving constrained and unconstrained optimization problems. Numerical solutions of nonlinear algebraic systems. Convergence, error analysis. Hardware and software influences. Efficiency, accuracy, and reliability of software.

Robust computer codes. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4445, MATH 4446

Corequisite(s):

MATH 5486 (CS 5486):

Numerical Analysis and Software

Presentation and analysis of numerical methods for solving common mathematical and physical problems. Methods of solving large sparse linear systems of equations, algebraic eigenvalue problems, and linear least squares problems. Numerical algorithms for solving constrained and unconstrained optimization problems. Numerical solutions of nonlinear algebraic systems. Convergence, error analysis. Hardware and software influences. Efficiency, accuracy, and reliability of software.

Robust computer codes. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4445, MATH 4446

Corequisite(s):

MATH 5495:

Mathematical Methods in Engineering I,ii

Linear algebra and matrix theory, vector calculus, complex variables and integral transforms, ordinary and partial differential equations, special functions, integral equations and calculus of variations. Facility with an existing math software package knowledge of senior level engineering mathematics required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5496:

Mathematical Methods in Engineering I,ii

Linear algebra and matrix theory, vector calculus, complex variables and integral transforms, ordinary and partial differential equations, special functions, integral equations and calculus of variations. Facility with an existing math software package knowledge of senior level engineering mathematics required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5515 (GBCB 5515):

Mathematical Methods for Modeling and Simulation of Biological Systems

Introduction to mathematical techniques for modeling and simulation, parameter identification and analysis of biological systems. Emphasis on both theoretical and practical issues and methods of computation, with concrete applications. Suitable for students from the mathematical and life sciences who have a basic foundation in multivariate calculus and ordinary differential equations. 5515: Continuous models and methods. 5516: Discrete models and methods.

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5516:

Mathematical Methods for Modeling and Simulation of Biological Systems

Introduction to mathematical techniques for modeling and simulation, parameter identification and analysis of biological systems. Emphasis on both theoretical and practical issues and methods of computation, with concrete applications. Suitable for students from the mathematical and life sciences who have a basic foundation in multivariate calculus and ordinary differential equations. 5515: Continuous models and methods. 5516: Discrete models and methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5524:

Matrix Theory

Determinants, rank, linear systems, eigenvalues, diagonalization, Gram-Schmidt process, Hermitian and unitary matrices, Jordan canonical form, variational principles, perturbation theory, Courant minimax theorem, Weyl's inequality, numerical methods for solving linear systems and for determining eigenvalues. science or engineering. III

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5545:

Calculus of Variations and Optimal Control Theory

Unified course in the calculus of variations and control theory including multiple integral problems and distributed parameter control systems. Necessary conditions, sufficient conditions, nonclassical problems, optimal control, distributed parameter control, computational methods. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4525, MATH 4425

Corequisite(s):

MATH 5546:

Calculus of Variations and Optimal Control Theory

Unified course in the calculus of variations and control theory including multiple integral problems and distributed parameter control systems. Necessary conditions, sufficient conditions, nonclassical problems, optimal control, distributed parameter control, computational methods. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4525, MATH 4425, MATH 5545

Corequisite(s):

MATH 5614:

Topics for In-Service Teachers

Various topics in mathematics and its applications to real-life problems, presented in light of contemporary instructional technologies and standards of learning. The course is designed for in-service mathematics teachers at the high and middle school levels and is suitable for recertification credit. The specific topics covered will be tailored to the location and delivery mode of the course, as well as evolving standards and methodology. May be repeated for credit with different content. May not be applied toward graduate degrees in mathematics. In-service status required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

MATH 5634:

Research in Undergraduate Mathematics Education

Research on undergraduate mathematics education. Student understanding of particular concepts from undergraduate math courses, from calculus to abstract algebra. Student engagement in mathematical practices, such as proving and defining, that transcend particular course concepts. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

127 Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5725:

Mathematics for Financial Modeling

Introduction to stochastic models used in financial market analysis and associated computational methods. 5725: Brownian motion, stochastic integration, Ito calculus, martingales, no-arbitrage pricing, Black-Scholes formula, basic term-structure models. 5726: PDE characterizations for American, Asian and various other path-dependent options, development and application of numerical methods for computation.

Must meet pre-requisites or have instructor's consent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5425, MATH 5426

Corequisite(s):

MATH 5726:

Mathematics for Financial Modeling

Introduction to stochastic models used in financial market analysis and associated computational methods. 5725: Brownian motion, stochastic integration, Ito calculus, martingales, no-arbitrage pricing, Black-Scholes formula, basic term-structure models. 5726: PDE characterizations for American, Asian and various other path-dependent options, development and application of numerical methods for computation.

Must meet pre-requisites or have instructor's consent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5425, MATH 5426

Corequisite(s):

MATH 5754:

Introduction to Perturbation Methods

Asymptotic expansions and series, approximate solutions of algebraic equations, straightforward expansions and their regions of nonuniformities, the Lindstedt-Poincare technique, the method of renormalization, the method of averaging, the method of matched asymptotic expansions. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 2214 OR MATH 2514 OR MATH 4544

Corequisite(s):

MATH 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

MATH 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MATH 6125:

Topics in Algebra

Advanced topics in algebra for graduate students in mathematics. May be taken for credit more than once with department consent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5126

Corequisite(s):

MATH 6126:

Topics in Algebra

Advanced topics in algebra for graduate students in mathematics. May be taken for credit more than once with department consent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5126

Corequisite(s):

MATH 6225:

Topics in Analysis

Advanced analysis for graduate students in mathematics. May be taken for credit more than once with department consent. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 6226:

Topics in Analysis

Advanced analysis for graduate students in mathematics. May be taken for credit more than once with department consent. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 6255:

Functional Analysis

Banach spaces, Hilbert spaces, linear operators on Banach and Hilbert spaces, Riesz Representation Theorems, spectral theory, topological vector spaces, other topics in functional analysis. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5226

Corequisite(s):

MATH 6256:

Functional Analysis

Banach spaces, Hilbert spaces, linear operators on Banach and Hilbert spaces, Riesz Representation Theorems, spectral theory, topological vector spaces, other topics in functional analysis. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5226, MATH 6255

Corequisite(s):

MATH 6324:

Topics in Topology and Geometry

Advanced topics in topology and geometry. May be taken for credit more than once with department consent, with different content.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5344

Corequisite(s):

MATH 6425:

Top in Applied Math

Advanced topics in applied mathematics for graduate students in mathematics, science, and engineering. May be taken for credit more than once with department consent. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MATH 6426:

Topics in Applied Mathematics

Advanced topics in applied mathematics for graduate students in mathematics, science, and engineering. May be taken for credit more than once with department consent. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

129 Corequisite(s):

MATH 6755:**Mathematical Foundations of Quantum Mechanics**

Advanced course in mathematical physics which encompasses the frontiers of research in quantum theory. Content varies from year to year and includes scattering theory, spectral and perturbation theory, and many-body quantum dynamics. This course frequently taken concurrent with thesis research. The course alternates with Math 6745-6746 and may be taken a second time with instructor's consent. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 6256, PHYS 5456

Corequisite(s):

MATH 6756:**Mathematical Foundations of Quantum Mechanics**

Advanced course in mathematical physics which encompasses the frontiers of research in quantum theory. Content varies from year to year and includes scattering theory, spectral and perturbation theory, and many-body quantum dynamics. This course frequently taken concurrent with thesis research. The course alternates with Math 6745-6746 and may be taken a second time with instructor's consent. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 6256, PHYS 5456, MATH 6755

Corequisite(s):

MATH 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHYSICS

Leo Piilonen, Chair

Professors: Lay Chang; James Heflin; Jean Heremans; Jonathan Link; Djordje

Minic; Pendleton Montague; Seong Mun; Leo Piilonen; Mark Pitt; Michel Pleimling;

John Simonetti; Uwe Tauber; Robert Vogelaar;

Associate Professors: Nahum Arav; Patrick Huber; Giti Khodaparast; Kyungwha Park; Hans Robinson; Vito Scarola; Eric Sharpe; Victoria Soghomonian; Tatsu Takeuchi;**Assistant Professors:** Lara Anderson; Shengfeng Cheng; Duncan Farrah; James Gray; Camillo Mariani; William Mather; Vinh Nguyen; Chenggang Tao;**Research Faculty:** Ibrahim Ozcan; Kenneth Wong;**Adjunct Professors:** Richard Blankenbecler; Charles Bowman; Zheng Chang; Frank Giovane; Yi-Gao Liang; Zoltan Toroczkai;**Affiliated Faculty:** Levon Asryan; Stephen Eubank; Louis Guido; Rolf Mueller; Alexey Onufriev; Mark Paul;**William E. Hassinger, Jr., Senior Faculty Fellow in Physics:** Leo Piilonen;**Graduate Contact:** gradphys@vt.edu**Graduate Program Coordinator:** bewilki2@vt.edu**Graduate Site:** <http://www.phys.vt.edu/students/grads.shtml>**Student Handbook:** <http://www.phys.vt.edu/students/GraduateHandbook.pdf>

The Department of Physics offers program coursework and research leading to M.S. (thesis optional) and Ph.D. degrees. Details about the M.S. and Ph.D. degree options can be found in our graduate program policies document available at <http://www.phys.vt.edu/students/grads.shtml>. The Department has internationally recognized excellence in experimental and/or theoretical aspects of astronomical, biological, biomedical, condensed matter, mathematical, nuclear, and particle physics. This research is supported by collaborations with researchers across Virginia Tech and at outside institutions of higher learning. Please visit the Department at <http://www.phys.vt.edu/research/> for more information.

SPECIAL FACILITIES

Experimental laboratories within the Department of Physics include facilities employing Raman scattering, far-infrared to near-ultraviolet spectroscopy, conventional and superconducting magnets, thin-film electron scattering, susceptometry, sol-gel studies, laser holography and spatial filtering, and pulsed laser nonlinear optical measurements such as harmonic generation and degenerate four-wave mixing, and clean-room. Other techniques and materials are available via collaborative programs with the Departments of Chemistry, Chemical Engineering, and Materials Science. Facilities are maintained in the Department of Physics to prepare experiments and analyze data collected by the radio astronomy and elementary particle groups which are currently working at national and international research centers, including FermiLab (FNAL, Illinois), Brookhaven National Laboratory (BNL, New York), Thomas Jefferson National Accelerator Facility (TJNAF, Virginia), Oak Ridge National Laboratory (ORNL, Tennessee), Laboratori Nazionali del Gran Sasso (LNGS, Italy), Kou Enerugii Kasokukikenkyuukikou (KEK, Japan), Los Alamos National Laboratory (LANL, New Mexico), Kimballton underground science and engineering facility (Virginia), and National Radio Astronomy Observatory (NRAO, including the VLA and VLBA). Housed in the department is the university's Center for Neutrino Physics (CNP). Virginia Tech university computing offers multiple high-performance computing systems. The Physics department has two dedicated clusters and a distributed collection of about 200 limited-availability nodes, all running Linux. Access to supercomputers is available through national and international networks. The Physics

department operates a professional machine shop, a computer shop, and a student shop.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal, Quantitative, Analytical

GRE

Subject: Physics

Degree requirements include courses, both required and elective, thesis research, and examination(s). The credit requirement for a Ph.D. is 90 hours, including a maximum of 60 hours of research and dissertation. For the M.S., there are two options, thesis and non-thesis, both of which require 30 credit hours. In the non-thesis option, at least 24 hours of course work are required, while the thesis option requires at least 20 hours of courses and 6-10 hours of thesis research, respectively.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal, Quantitative, Analytical

GRE

Subject: Physics

Degree requirements include courses, both required and elective, thesis research, and examination(s). The credit requirement for a Ph.D. is 90 hours, including a maximum of 60 hours of research and dissertation. For the M.S., there are two options, thesis and non-thesis, both of which require 30 credit hours. In the non-thesis option, at least 24 hours of course work are required, while the thesis option requires at least 20 hours of courses and 6-10 hours of thesis research, respectively.

GRADUATE COURSES (PHYS)

PHYS 5354:

Classical Mechanics

Theory of classical Lagrangian and Hamiltonian mechanics of particles and rigid bodies, including canonical transformations and Hamilton-Jacobi theory. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5405:

Classical Electromagnetism

Classical theory of electromagnetism and its applications. 5405:

Electrostatics and magnetostatics; Maxwell's equations and electromagnetic waves; wave guides, apertures, and antennae. 5406:

Special relativity and Lagrangian and Hamiltonian formulations; Lienard-Wiechert potentials, motion, radiation, and energy loss by charged particles; self-fields and radiative damping; magnetic monopoles and field theories. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): PHYS 5714

PHYS 5406:

Classical Electromagnetism

Classical theory of electromagnetism and its applications. 5405:

Electrostatics and magnetostatics; Maxwell's equations and electromagnetic waves; wave guides, apertures, and antennae. 5406:

Special relativity and Lagrangian and Hamiltonian formulations; Lienard-Wiechert potentials, motion, radiation, and energy loss by charged particles; self-fields and radiative damping; magnetic monopoles and field theories. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5405

Corequisite(s): PHYS 5714

PHYS 5455:

Quantum Mechanics

General principles of nonrelativistic quantum mechanics from the point of view of advanced dynamics, with applications to problems of atomic and nuclear structure. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5456:

Quantum Mechanics

General principles of nonrelativistic quantum mechanics from the point of view of advanced dynamics, with applications to problems of atomic and nuclear structure. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5455

Corequisite(s):

PHYS 5504:

Nuclear and Particle Physics

Properties of nuclei, two-nucleon systems, nuclear force, nuclear models, nuclear reactions, alpha and beta decay, and fission. Relativistic kinematics, invariance principles, quantum numbers, strange particles, weak interactions, formation and production reactions, and symmetries.

Consent required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5555:

Solid-State Physics

Solidity, crystal structure, k-space, quantum mechanics of covalent bonding, phonon excitations, thermal energy, the nearly-free-electron approximation, Bloch electrons, E(k) energy bands in semiconductors and metals, density of states, optical properties of solids, donors and acceptors in semiconductors, excitons, plasmons, polaritons, electrical properties, magnetic materials, the percolation model and phase transitions, metal-insulator transitions, and amorphous solids. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5556:

Solid-State Physics

Solidity, crystal structure, k-space, quantum mechanics of covalent bonding, phonon excitations, thermal energy, the nearly-free-electron approximation, Bloch electrons, E(k) energy bands in semiconductors and metals, density of states, optical properties of solids, donors and acceptors in semiconductors, excitons, plasmons, polaritons, electrical properties, magnetic materials, the percolation model and phase transitions, metal-insulator transitions, and amorphous solids. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5574G:

Intermediate Nanotechnology

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5614:

Introduction to Quantum Electronics

Theory of laser oscillation, optical resonators, interaction of radiation and atomic systems, giant pulsed lasers, laser systems, wave propagation in nonlinear media, modulation of optical radiation, noise in optical detection and generation, and interaction of light and sound. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 4614

Corequisite(s):

PHYS 5614G:

Intermediate Optics

in modern optics with contemporary applications. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5654G:

Advanced 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 Friedmann-Lemaître-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: Graduate standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5674G:

Intermediate General Relativity

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 spacetime; black holes; cosmology; Einstein's gravitational field equations; gravitational waves and relativistic stars. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5705:

Statistical Mechanics

Theory of classical and quantum statistical mechanics. Derivation of thermodynamics. 5705: ensembles, fluctuations and ideal gas systems. 5706: modern developments and advanced topics. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): , PHYS 5456

Corequisite(s):

PHYS 5706:

Statistical Mechanics

Theory of classical and quantum statistical mechanics. Derivation of thermodynamics. 5705: ensembles, fluctuations and ideal gas systems. 5706: modern developments and advanced topics. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5456, PHYS 5705

Corequisite(s):

PHYS 5714:

Methods of Theoretical Physics

Selected topics in mathematical physics. Review of analytic function theory. Matrices, spectral theory of operators in Hilbert Space with applications to quantum mechanics. Solution of partial differential equations of mathematical physics, boundary-value problems, and special functions. Distribution theory and Green's functions. Consent required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5714G:

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5774G:**Advanced 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: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5794:**Computational Physics**

Survey of computational methods in physics. Applications of Fourier analysis, curve fitting, solving differential equations, solving integral equations, Monte Carlo simulations, symbolic mathematics, and graphic simulations in mechanics, electromagnetism, nuclear physics, atomic physics, molecular physics, and condensed matter physics. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 4455

Corequisite(s):

PHYS 5894:**Final Examination**

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5904:**Project and Report**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHYS 5944:**Seminar**

May be repeated one time with different content for a maximum of 2 credits.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

PHYS 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHYS 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHYS 6455:**Advanced Quantum Theory**

Classical field theory; Noether's theorem and symmetries; second quantization and many-body formalism; free quantum Klein-Gordon, Dirac, and Maxwell fields; and interacting fields, S-matrix and covariant perturbation theory. Feynman diagrams; quantum electrodynamics; renormalization; path-integral formulation; non-Abelian gauge theories;

and elements of electro-weak theory. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5354, PHYS 5406, PHYS 5456

Corequisite(s):

PHYS 6456:

Advanced Quantum Theory

Classical field theory; Noether's theorem and symmetries; second quantization and many-body formalism; free quantum Klein-Gordon, Dirac, and Maxwell fields; and interacting fields, S-matrix and covariant perturbation theory. Feynman diagrams; quantum electrodynamics; renormalization; path-integral formulation; non-Abelian gauge theories; and elements of electro-weak theory. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5354, PHYS 5406, PHYS 5456, PHYS 6455

Corequisite(s):

PHYS 6555:

Advanced Solid-State Physics

Applications of field-theory techniques to many-body aspects of solid-state physics. 6555: Green functions, Feynman diagrams, lattice Hamiltonian, neutron scattering, electron gas, Fermi-liquid theory, and linear-response theory. 6556: Electron-phonon interaction in metals and semiconductors, polarons, optical properties, excitons, superconductivity, and excitations in magnetic materials. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5456, PHYS 5555

Corequisite(s):

PHYS 6556:

Advanced Solid-State Physics

Applications of field-theory techniques to many-body aspects of solid-state physics. 6555: Green functions, Feynman diagrams, lattice Hamiltonian, neutron scattering, electron gas, Fermi-liquid theory, and linear-response theory. 6556: Electron-phonon interaction in metals and semiconductors, polarons, optical properties, excitons, superconductivity, and excitations in magnetic materials. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5456, PHYS 5555

Corequisite(s):

PHYS 6675:

General Relativity and Cosmology

6675: Differential geometry; equivalence principle; general theory of relativity; classical tests; post-Newtonian approximation; special solutions. 6676: Black holes; observational basis of cosmology; relativistic model universes; nucleosynthesis; cosmic background radiation; dark matter; inflation. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5354, PHYS 5406

Corequisite(s):

PHYS 6676:

General Relativity and Cosmology

6675: Differential geometry; equivalence principle; general theory of relativity; classical tests; post-Newtonian approximation; special solutions. 6676: Black holes; observational basis of cosmology; relativistic model universes; nucleosynthesis; cosmic background radiation; dark matter; inflation. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5354, PHYS 5406

Corequisite(s):

PHYS 6714:

Selected Topics in Theoretical Physics

Topics of current interest in theoretical physics as announced in Timetable. May be repeated for credit with permission. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Elementary Particle Physics

Symmetry principles, quark model, scattering-theory and particle-theory processes, weak interactions, quantum chromodynamics, spontaneous symmetry breaking, and unified field theories. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): PHYS 6455, PHYS 6456

PHYS 6726:

Elementary Particle Physics

Symmetry principles, quark model, scattering-theory and particle-theory processes, weak interactions, quantum chromodynamics, spontaneous symmetry breaking, and unified field theories. Consent required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 6725

Corequisite(s): PHYS 6455, PHYS 6456

PHYS 6755:

Mathematical Foundations of Quantum Mechanics

Advanced course in mathematical physics which encompasses the frontiers of research in quantum theory. Content varies from year to year and includes scattering theory, spectral and perturbation theory, and many-body quantum dynamics. This course frequently taken concurrent with thesis research. The course alternates with Math 6745-6746 and may be taken a second time with instructor's consent. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5456, MATH 6256

Corequisite(s):

PHYS 6756:

Mathematical Foundations of Quantum Mechanics

Advanced course in mathematical physics which encompasses the frontiers of research in quantum theory. Content varies from year to year and includes scattering theory, spectral and perturbation theory, and many-body quantum dynamics. This course frequently taken concurrent with thesis research. The course alternates with Math 6745-6746 and may be taken a second time with instructor's consent. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHYS 5456, MATH 6256, PHYS 6755

Corequisite(s):

PHYS 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PSYCHOLOGY

Robert Stephens, Head

Professors: Martha Ann Bell; Warren Bickel; George Clum; Kirby Deater-Deckard; Jack Finney; E Geller; Russell Jones; Thomas Ollendick; Robert Stephens; Richard Winnett;

Associate Professors: Danny Axsom; Lee Cooper; Julie Dunsmore; Roseanne Foti; Joseph Germana; David Harrison; Robert Harvey; Neil Hauenstein; Jungmeen Kim-Spoon; Robin Panneton; Angela Scarpa-Friedman; Bruce Scarpa-Friedman; Susan White;

Assistant Professors: Anthony Cate; Pearl Chiu; Rachel Diana; Brooks King-Casas; John Richey; Bradley White;

Research Faculty: Eileen Bill; Sharon Ramey; Craig Ramey;

Alumni Distinguished Professor: E Geller;

University Distinguished Professor: Thomas Ollendick;

Heilig Meyers Professor: Richard Winnett;

Senior Instructors: Kurt Hoffman;

Graduate Contact: sanderson@vt.edu

Graduate Site: <http://www.psyc.vt.edu/graduate/>

The Department of Psychology at Virginia Tech offers graduate programs leading to the Ph.D. in four areas: Clinical Psychology, Developmental Science, Industrial/Organizational Psychology, and Neuroscience & Biological Psychology. Students earn a Master of Science (M.S.) degree in psychology en route to the Ph.D., but the department does not offer a terminal M.S. degree in any area. Applications from students with either bachelors or advanced degrees are welcomed. Although the graduate curriculum is organized into four specialty areas, all share the same philosophy: to assure that all graduate students are provided with the conceptual, quantitative, and methodological skills necessary to solve theoretical and applied problems.

SPECIAL FACILITIES

Williams Hall is the on-campus home of the Department of Psychology, housing faculty and student offices, research labs, and classrooms. In addition, the department's off-campus Psychological Services Center and Child Study Center provide the foundation for practicum and research training and offer direct clinical services to children, adults, and families. Additional department resources include three state-of-the-art laboratories dedicated to undergraduate and graduate teaching and research. The psychophysiological laboratory includes computer workstations, EEG/Evoked Potential workstations (including Neuroscan, Coulbourn, and BioPAC equipment), visual acuity and tracking equipment, as well as extensive perception equipment. The psychophysiology laboratory also houses the department's STISIM Drive fully-interactive driving simulator. The department also maintains a computer lab with 20 Dell Optiplex workstations for technology-assisted teaching and research with neurophysiological and cognitive experimental software, statistical analysis software, and data management programs. The newly-opened dedicated-research computer laboratory includes 12 Dell Optiplex workstations with capabilities for running a variety of customized research software. Several faculty are affiliated with the Virginia Tech Carilion Research Institute (<http://info.vtc.vt.edu/phd/>), which offers world-class facilities for behavioral research, the world's premier human functional magnetic resonance imaging facility, and large-scale computational clusters for modeling, simulations, and analyses of large-scale molecular, genomic, biophysical, behavioral, imaging, and population-based data. The Institute also serves as the hub for a worldwide hyperscanning network for interactive, real-time functional brain imaging. Connecting the Institute's three research-dedicated magnetic resonance imaging scanners to multiple sites across the United States and throughout Europe and Asia, this network provides the world's first very-high-throughput functional brain imaging approach to the study of social cognition. This work is enabling new insights not only into how the brains of healthy children and adults make decisions, but also how traumatic brain injury, post-traumatic stress disorder, and a range of neuropsychiatric disorders affect critical decision-making processes.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

M.S.: University minimums for research/thesis and non-thesis credit hours, plus additional specified courses and completion of a Thesis. Details may be found in our student handbook.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Ph.D.: University minimums for research/dissertation and non-dissertation credit hours plus additional specified courses and completion of a Preliminary Examination and Dissertation. Details may be found in our student handbook.

GRADUATE COURSES (PSYC)

PSYC 5114:

Survey of Industrial Psychology

Survey of major topics in Industrial Psychology. Emphasis is placed on theories and empirical research in the areas of psychological testing, prediction of job performance, criterion development, performance appraisal, performance management, decision theory in personnel selection, utility analysis, affirmative action, legal issues in human resource management, diversity programs, job analysis, and training and development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5124:

Survey of Organizational Psychology

Provides a survey of topics relevant to the field of Organizational Psychology. Micro-level topics include motivation, attitudes, organizational entry, commitment and withdrawal. Macro-level topics include leadership, leadership-member theories, organizational development and systems theory. The course will emphasize theoretical and research issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5134:

Advanced Psychometric Theory

Course focuses on the development and evaluation of psychological measures. Topics covered will focus on test development, classical test

theory, and item-response theory.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5605, STAT 5606 OR STAT 5615, STAT 5616

OR STAT 5665, STAT 5666

Corequisite(s):

PSYC 5274:

Personality Processes

Theory, research, and application in contemporary personality psychology.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5284:

Psychopathology

Fundamental theory and research in the area of psychopathology. Emphasis on empirically derived theories and data concerned with assessment and description of psychopathological behavior.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5294:

Psychophysiology

Intensive study of the distinct psychophysiological methodology and approach to the problem of physiological-behavioral correlation. Several primary areas of psychophysiology are presented: autonomic-somatic integration and the measurement of psychophysiological activity, the orienting reflex and habituation, the psychophysiological correlates of learning, and patterning factors in psychophysiological response.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5314:

Psychological Perspectives in Social Psychology

Examines reinforcement, field theoretic, cognitive, and role theory, and social learning theory and aggression, social exchange theories, social facilitation, group dynamics, attribution theory, environmental psychology, and impression management.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5315:

Research Methods

Advanced treatment of a variety of research related issues germane to the discipline of psychology, including: the scientific method, elements of the research process, alternative strategies for operationalizing variables, sampling, research ethics, experimental research, quasi-experimental research, non-experimental research, research artifacts, non-traditional research strategies, quantitative literature reviews, and legal problems in research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5316:

Research Methods

Advanced treatment of a variety of research related issues germane to the discipline of psychology, including: the scientific method, elements of the research process, alternative strategies for operationalizing variables, sampling, research ethics, experimental research, quasi-experimental research, non-experimental research, research artifacts, non-traditional research strategies, quantitative literature reviews, and legal problems in research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5344:

Survey of theoretical and empirical issues in cognitive psychology, including information processing models, attention, memory, problem solving, knowledge, reasoning, neurocognition and intelligence.

Historical and current approaches will be considered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5374:

Health Psychology

Theoretical and methodological contributions of the behavioral sciences to problems in the health sciences. Topics include psychosocial factors contributing to health and disease, health promotion, and psychological approaches to the prevention and treatment of physical disabilities.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5404:

Biological Bases of Behavior

History, methods, and special topics relevant to the biological foundations of behavior. Emphasis placed on anatomy, physiology, and pharmacology of nervous system and behavioral correlates including perception, learning memory, motivation, and language.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5534:

Developmental Psychology

Examines the processes underlying cognitive and social development through the life span. In addition to the critical examination of theories exploring changes in cognition and social behavior, the relative role of phylogeny and ontogeny are explored and evaluated.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5544:

Cognitive Development

Cognitive development throughout the life-span. Emphasis on Piaget's theory of cognitive development, information-processing approaches, perceptual development, memory development, language development, and alternatives to Piagetian theory. Coverage of the development of social-cognition, particularly communication.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSYC 5534

Corequisite(s):

PSYC 5554:

Social Development

Development of social competence and interactive style during infancy and childhood. Both prenatal and postnatal determinants of normal social behavior, aggression, sex role development, and nonoptimal child-environment interactions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSYC 5534

Corequisite(s):

PSYC 5965:

Clinical Practicum

Supervised training appropriate to the student's level of coursework and experience in interviewing, assessment, intervention techniques, community consultation, and applied research in a variety of on and off-campus settings. Maximum of 3 credit hours per course. Approximately 16 hours per week will be the normal training assignment for 3 hours credit; approximately 11 hours per week for 2 hours credit; and approximately 6 hours per week for 1 hour credit.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 16

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Clinical Practicum

Supervised training appropriate to the student's level of coursework and experience in interviewing, assessment, intervention techniques, community consultation, and applied research in a variety of on and off-campus settings. Maximum of 3 credit hours per course. Approximately 16 hours per week will be the normal training assignment for 3 hours credit; approximately 11 hours per week for 2 hours credit; and approximately 6 hours per week for 1 hour credit.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 16

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

PSYC 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PSYC 6014:

Quantitative Topics in Industrial and Organizational Psychology

Seminar provides in-depth consideration of one or more current or emergent quantitative topics relevant to the field of Industrial and Organizational Psychology. Example topics include multi-level theories

and analytical techniques, meta-analysis, and generalizability theory.

May be repeated with different content for a maximum of 6 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSYC 5315, (STAT 5605, STAT 5606) OR (STAT 5615, STAT 5616) OR (STAT 5665, STAT 5666)

Corequisite(s):

PSYC 6254:

Advanced Topics in Clinical Psychology

Seminar covering specialized topics in clinical psychology. The course will be concerned with such topics as clinical neuropsychology, pediatric psychology, the psychology of aging, biochemical theories of schizophrenia, and professional and ethical issues. May be repeated to a maximum of 9 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 6264:

Child Psychopathology

An examination of theoretical issues and current research in the assessment, treatment, and prevention of child behavior disorders. Special emphasis will be placed upon developmental factors and system-wide variables as they impact on the growing child.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSYC 5284

Corequisite(s):

PSYC 6404:

Behavior Management in Large-scale Systems

Theoretical and empirical overview of the management of human behavior in community, institutional, and organizational environments. Methodologies for evaluation and refining specific intervention procedures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 6924:

Advanced Topics in Industrial Psychology

Seminar that provides in-depth coverage of theoretical perspectives, research findings, and research strategies used in the study of Industrial Psychology. Topics covered will focus on current research in the areas of selection and criterion development. May be repeated with different content for a maximum of 6 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSYC 5114 OR PSYC 5115, (STAT 5605, STAT 5606)

OR (STAT 5615, STAT 5616) OR (STAT 5665, STAT 5666)

Corequisite(s):

PSYC 6934:

Advanced Topics in Organizational Psychology

Seminar that provides in-depth coverage of theoretical perspectives, research findings, and research strategies used in the study of Organizational Psychology. Topics covered will focus on current research in the areas of micro and macro organizational psychology. May be repeated with different content for a maximum of 6 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSYC 5124 OR PSYC 5125 OR PSYC 5126, (STAT

5605, STAT 5606) OR (STAT 5615, STAT 5616) OR (STAT 5665, STAT

5666)

Corequisite(s):

PSYC 6944:

Advanced Topics in Developmental Psychology

Seminar covering specialized topics in developmental psychology. The course will be concerned with such topics as the life-span perspective, early identification of at-risk newborns, preventive interventions, and new conceptual foundations. May be repeated to a maximum of 9 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 6954:

Advanced Topics in Psychological Sciences

Seminar covering advanced, specialized biobehavioral topics in Psychological Sciences. The course will be concerned with such topics as biobehavior, psychophysiology, cognitive neuroscience, sensation and perception, learning and cognitive psychology. May be repeated to a maximum of 12 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 6965:

Clinical Practicum

Supervised training appropriate to the student's level of coursework and experience in interviewing, assessment, intervention techniques, community consultation, and applied research in a variety of on- and off-campus settings. Maximum of 3 credit hours per course. Approximately 16 hours per week will be the normal training assignment for 3 hours credit; approximately 11 hours per week for 2 hours credit; and approximately 6 hours per week for 1 hour credit.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 6966:

Clinical Practicum

Supervised training appropriate to the student's level of coursework and experience in interviewing, assessment, intervention techniques, community consultation, and applied research in a variety of on- and off-campus settings. Maximum of 3 credit hours per course. Approximately 16 hours per week will be the normal training assignment for 3 hours credit; approximately 11 hours per week for 2 hours credit; and approximately 6 hours per week for 1 hour credit.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 16

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 7965:

Internship

During the third or fourth year the clinical student shall be involved in a full-time supervised internship program in a clinical setting approved by his advisory committee and the director of clinical psychology training program. The minimum duration shall be 11 months.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 7966:

Internship

During the third or fourth year the clinical student shall be involved in a full-time supervised internship program in a clinical setting approved by his advisory committee and the director of clinical psychology training program. The minimum duration shall be 11 months.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSYC 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

STATISTICS

Eric Smith, Head

Professors: Jeffrey Birch; Ina Hoeschele; John Morgan; Eric Smith; Gordon

Vining; William Woodall;

Associate Professors: Pang Du; Marco Ferreira; Feng Guo; Inyoung Kim; Scott

Leman; George Terrell;

Assistant Professors: Xinwei Deng; Yili Hong; Leanna House; Runlong Tang;

Xiaowei Wu; Hongxiao Zhu;

Research Faculty: Christopher Franck; Jie Li; Eric Vance;

Graduate Contact: chconne1@vt.edu

Director of Graduate Programs: jbbirch@vt.edu

Graduate Site: <http://www.stat.vt.edu/graduate/index.html>

Student Handbook: <http://www.stat.vt.edu/graduate/graduate-handbook.html>

Founded in 1949, the Department of Statistics at Virginia Tech is the third oldest in the nation. Our program specializes in training students in statistical theory balanced with extensive applications including practical experience via the Laboratory for Interdisciplinary Statistical Analysis (LISA). Over 700 master's degrees and 300 doctoral degrees have been awarded by the department. The 18-month master's program is a model of the time-efficient education of statisticians. The doctoral program includes specialized tracks in traditional and industrial statistics, bioinformatics, computational statistics, and environmetrics.

SPECIAL FACILITIES

Through the Laboratory for Interdisciplinary Statistical Analysis, students in cooperation with faculty members become involved in on-campus consulting activities. M.S. students are required to participate in statistical consulting within the Laboratory for Interdisciplinary Statistical Analysis (LISA) for at least one semester and Ph.D. students for at least three semesters. The department has several laboratories housing state-of-the-art Linux and PC networks. Students have access to these for consulting, course work, and research. Students gain extensive experience with modern statistical software for experimental design, data management and analysis, and computer programming for statistical purposes.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal, Quantitative (700.0), Analytical

The M.S. plan of study requires 35 semester hours of work, of which 32 semester hours must be taken within the department. Additional courses rounding out a plan of study may be taken at the graduate level in applied or theoretical statistics, mathematics, or in approved areas of application. Each student must pass a qualifying examination after

completing the core courses and a final oral examination after completing the plan of study. The Ph.D. plan of study requires a minimum of 90 semester hours of work beyond the baccalaureate, including at least 59 semester hours of coursework and at least 30 semester hours of research toward the dissertation. In addition to the core courses for the M.S. (or equivalent courses if a student enters the program with advanced standing from another university), required courses for the Ph.D. are Advanced Topics in Statistical Inference and three other Ph.D. level courses from approved lists of courses, which vary by track. Each candidate for the Ph.D. must pass the qualifying examination at the Ph.D. level. Flexibility is provided to the graduate program through five Ph.D. concentrations or tracks, which include the Traditional Track, the Industrial Track, the Bioinformatics Track, the Computational Track, and the Environmental Track. The Traditional Track encompasses the general pursuit of research in statistical theory and methods, allowing considerable freedom in choice of coursework within and outside the department. The Industrial, Bioinformatics, Computational, and Environmental Tracks offer more specialized statistical training geared toward application areas in which the department has particular expertise. In accord with their specialized nature, these four tracks are more stringent in requirements for relevant coursework than the Traditional Track. An option in Bioinformatics is also available.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal, Quantitative (700.0), Analytical

The M.S. plan of study requires 35 semester hours of work, of which 32 semester hours must be taken within the department. Additional courses rounding out a plan of study may be taken at the graduate level in applied or theoretical statistics, mathematics, or in approved areas of application. Each student must pass a qualifying examination after completing the core courses and a final oral examination after completing the plan of study. The Ph.D. plan of study requires a minimum of 90 semester hours of work beyond the baccalaureate, including at least 59 semester hours of coursework and at least 30 semester hours of research toward the dissertation. In addition to the core courses for the M.S. (or equivalent courses if a student enters the program with advanced standing from another university), required courses for the Ph.D. are Advanced Topics in Statistical Inference and three other Ph.D. level courses from approved lists of courses, which vary by track. Each candidate for the Ph.D. must pass the qualifying examination at the Ph.D. level. Flexibility is provided to the graduate program through five Ph.D. concentrations or tracks, which include the Traditional Track, the Industrial Track, the Bioinformatics Track, the Computational Track, and the Environmental Track. The Traditional Track encompasses the general pursuit of research in statistical theory and methods, allowing considerable freedom in choice of coursework within and outside the department. The Industrial, Bioinformatics, Computational, and Environmental Tracks offer more specialized statistical training geared toward application areas in which the department has particular expertise. In accord with their specialized nature, these four tracks are more stringent in requirements for relevant coursework than the Traditional Track. An option in Bioinformatics is also

available.

GRADUATE COURSES (STAT)

STAT 5014:

Introduction to Statistical Program Packages

Introduction to computing facilities (mainframe and microcomputers), conversational monitoring system (CMS), and statistical program computer packages. Restricted to Statistics majors. I

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): STAT 5004

STAT 5024:

Effective Communication in Statistical Consulting

Communication skills necessary to be effective interdisciplinary statistical collaborators. Explaining and presenting statistical concepts to a non-statistical audience, helping scientists answer their research questions, and managing an effective statistical collaboration meeting.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5014 (UG)

Corequisite(s): STAT 5124, STAT 5204

STAT 5034:

Inference Fundamentals with Applications to Categorical Data

Fundamental ideas of statistical estimation and testing; principles and methods for standard one-sample settings; applications to categorical data problems. Topics include probability distributions, means, variances, and independence; point and interval estimation, including small and large sample procedures; hypothesis testing including exact and large-sample tests; goodness-of-fit; categorical data analysis; log-linear models; simple logistic regression.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5615, STAT 4584 OR MATH 4584

Corequisite(s): STAT 5014

STAT 5044:

Regression and Analysis of Variance

Principles and methods of data analysis employing linear models for continuous response variables. Topics include both classical descriptive measures and modern computer-based techniques for data visualization; simple, multiple and weighted regression; analysis of variance for one-way and higher-way classifications; fixed, mixed, and random effects models; analysis of covariance; detection and correction of modeling flaws; statistical power.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5615, STAT 4584 OR MATH 4584

Corequisite(s): STAT 5014

STAT 5104:

Probability and Distribution Theory

Fundamental concepts of probability, random variables and their distributions, functions of random variables, mathematical expectations, and stochastic convergence. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4526

Corequisite(s):

STAT 5114:

Statistical Inference

Decision theoretic formulation of statistical inference, concept and methods of point and confidence set estimation, notion and theory of hypothesis testing, relation between confidence set estimation and hypothesis testing. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): STAT 5104

STAT 5124:

Linear Models Theory

A study of the theory underlying the general linear model and general linear hypothesis. Applications in linear regression (full rank) and analysis of variance. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114, MATH 5524

Corequisite(s):

STAT 5204:

Experimental Design and Analysis I

Principles and concepts of experimental design; systematic overview and discussion of basic designs from the point of view of blocking, error reduction, and treatment structure; and development of analysis based on linear models. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5004 OR STAT 5616

Corequisite(s):

STAT 5204G:

Experimental Design: Concepts and Applications

Fundamental principles of designing and analyzing experiments with application to problems in various subject matter areas. Completely randomized, randomized complete block and Latin square designs, analysis of covariance, split-plot designs, factorial and fractional factorial designs, incomplete block designs, repeated measures, power and sample size, mean separation procedures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5605 OR STAT 5615

Corequisite(s):

STAT 5214G:

Advanced 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5605 OR STAT 5615

Corequisite(s):

STAT 5304:**Statistical Computing**

Computational methods for statistical computing problems. Orthogonal transformations, sweep operators, and other numerical methods applied to general optimization techniques for maximum likelihood and least squares estimation problems. Knowledge of SAS programming language required. Even years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5124

Corequisite(s):

STAT 5314:**Statistical Simulation**

Special computer techniques used in statistical simulation. Pseudo-random number generators, stochastic simulation, variance reduction techniques, and Monte Carlo applications. Knowledge of Fortran required. Odd years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114

Corequisite(s):

STAT 5334:**Exploratory and Robust Data Analysis**

Analysis of data by graphical and numerical techniques, statistical analysis of non-Gaussian data, topics in robust estimation for location, regression and correlation models, and the jackknife and bootstrap techniques. CMS. Even years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114

Corequisite(s):

STAT 5354:**Structured Process Improvement**

An introduction to the selection, management, leadership and execution of structured process improvement projects. Topics include effective roadmaps for process improvement, team facilitation and leadership, project selection and management, sampling, process capability analysis, data transformation, variance component analysis, response

surface methodology (including full and fractional factorial designs, Plackett-Burman designs, central composite designs, Box-Behnken designs, analysis of variance, regression, and multi-response optimization), and statistical process control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5004 OR STAT 5624

Corequisite(s):

STAT 5364:**Hierarchical Modeling**

Hierarchical modeling techniques as applied to assess data with atypical features, such as non-normal responses (e.g., binary, discrete survival, continuous mixtures), censored/missing observations, multivariate responses, repeated measures, and nested structures. Classical and Bayesian techniques for assessing models. Programming experience in R, S+, or Matlab required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5044, STAT 5104, STAT 5444

Corequisite(s):

STAT 5404:**Nonparametric Statistics**

Introduction to theory and methods of nonparametric statistical inference. General linear rank statistics, tests and estimation of location, dispersion, regression, and association. Selected topics. Odd years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5004, STAT 5114

Corequisite(s):

STAT 5414:**Time Series Analysis I**

Analysis of data when observations are not mutually independent, stationary and nonstationary time series, linear filtering, trend elimination, prediction, and applications in economics and engineering. Even years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114

Corequisite(s):

STAT 5434:

Applied Stochastic Processes

Stochastic processes in statistical applications including Markov chains, Poisson processes, renewal processes, branching processes, random walks, martales, Brownian motion and related stationary Gaussian processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5104

Corequisite(s):

STAT 5444:

Bayesian Statistics

Introductory course of Bayesian statistics on basic concepts of probability, Bayesian inference of Normal, Binomial, Poisson, Uniform and other common distributions, selections of prior information, Bayesian decision theory, Bayesian analysis of regression and analysis of variance and Bayesian foundation. Even years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114

Corequisite(s):

STAT 5454:

Reliability Theory

Basic concepts of lifetime distributions, types of censoring, inference procedures for exponential, Weibull and extreme value distributions, nonparametric estimation of survival function, kernel density estimation, accelerated life testing, and goodness of fit tests. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4106

Corequisite(s):

STAT 5474 (ISE 5474):

Statistical Theory of Quality Control

Development of statistical concepts and theory underlying procedures

used in quality control applications. Sampling inspection procedures, the sequential probability ratio test, continuous sampling procedures, process control procedures, and experimental design. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5104, STAT 5114

Corequisite(s):

STAT 5504:

Multivariate Statistical Methods

Methods of inference for multivariate distributions. Multivariate distributions, location and dispersion problems for one and two samples, multivariate analysis of variance, linear models, repeated measurements, inference for dispersion and association parameters, principal components, discriminant and cluster analysis, and simultaneous inference. Emphasis on robustness. Use of SAS.

Knowledge of CMS required. Even years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 4204 OR STAT 4706 OR STAT 5004 OR STAT 5616), (MATH 5524)

Corequisite(s):

STAT 5504G:

Advanced 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, principle components analysis, discriminant analysis, cluste analysis. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5616 OR STAT 5606

Corequisite(s):

STAT 5514:

Regression Analysis

Classical and modern techniques in regression analysis. Use of modern regression techniques to diagnose collinearity, leverage, and outliers.

146 Model discrimination using cross validation techniques. The study of

transformations, biased estimation, and nonlinear regression. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5124 OR STAT 5616

Corequisite(s):

STAT 5514G:

Advanced 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 or SPSS statistical software.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4706 OR STAT 5616

Corequisite(s):

STAT 5524:

Sample Survey Theory

Theory of sample surveys including major sampling designs, sample size determination, estimation and interval estimation, and questionnaire design. Even years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5004

Corequisite(s):

STAT 5524G:

Advanced 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 are also covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4706 (UG) OR STAT 5616

Corequisite(s):

STAT 5525 (CS 5525):

Data Analytics

Basic techniques in data analytics including the preparation and manipulation of data for analysis and the creation of data files from multiple and dissimilar sources. The data mining and knowledge discovery process. Overview of data mining algorithms in classification, clustering, association analysis, probabilistic modeling, and matrix decompositions. Detailed study of classification methods including tree-based methods, Bayesian methods, logistic regression, ensemble, bagging and boosting methods, neural network methods, use of support vectors and Bayesian networks. Detailed study of clustering methods including k-means, hierarchical and self-organizing map methods. Prerequisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5526 (CS 5526):

Data Analytics

Techniques in unsupervised and visualized learning in high dimension spaces. Theoretical, probabilistic, and applied aspects of data analytics. Methods include generalized linear models in high dimensional spaces, regularization, lasso and related methods, principal component regression (pca), tree methods, and random forests. Clustering methods including k-means, hierarchical clustering, biclustering, and model-based clustering will be thoroughly examined. Distance-based learning methods include multi dimensional scaling, the self organizing map, graphical/network models, and isomap. Supervised learning will consist of discriminant analyses, supervised pca, support vector machines, and kernel methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5525

Corequisite(s):

STAT 5534:

Analysis of Multivariate Categorical Data

Log-linear models for unconstrained and ordinal multidimensional contingency tables; testing and estimation; random and structural zeros; model building; logit models and logistic regression; and use of major statistical packages. Knowledge of CMS required. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5124
Corequisite(s):

STAT 5544:

Spatial Statistics

Spatial data structures: geostatistical data, lattices and point patterns. Stationary and isotropic random fields. Autocorrelated data structures. Semivariogram estimation and spatial prediction for geostatistical data. Mapped and sampled point patterns. Regular, completely random and clustered point processes. Spatial regression and neighborhood analyses for data on lattices.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5124
Corequisite(s):

STAT 5554:

Variance Components

Theoretical treatment of the general problem of estimating and testing hypotheses about variance components within the framework of random effects and mixed linear models; derivation of different estimation procedures and their statistical properties; and discussion of balanced and unbalanced data and of designs for estimating variance components. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5124
Corequisite(s):

STAT 5564:

Statistical Genetics

Statistical methods for linkage mapping of quantitative trait genes in populations ranging from inbred lines to complex pedigrees. Statistical methods to fine-map genes using linkage disequilibrium. Population genetic analyses of DNA sequence data. Statistical methods include multiple regression, (co)variance components estimation, Maximum Likelihood and Bayesian analyses. Algorithms to implement these methods include Expectation-Maximization, Markov chain Monte Carlo, neural networks, and genetic algorithms. Data are discrete or

continuous. Odd years.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): (STAT 5004) OR (STAT 5615, STAT 5616), (ALS 5105)
Corequisite(s):

STAT 5574:

Response Surface Design and Analysis I

Use of response surface analysis to design and analyze industrial experiments. First and second order models. First and second order experimental designs. Use of model diagnostics for finding optimum operating conditions. Even years. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5204
Corequisite(s):

STAT 5594:

Topics in Biostatistics

Course with variable content; specialized application of statistical theory and methodology to biological and medical sciences; topics include bioassay, epidemiology, survival analysis, and statistical ecology. May be repeated for credit with different topics. Odd years. III

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5114
Corequisite(s):

STAT 5605:

Biometry

5605: The normal distribution, estimation, hypothesis testing, simple linear regression, and one-way analysis of variance with applications to the biological sciences. 5606: Experimental design, nested and factorial analysis of variance, linear regression and correlation, and the use of SAS, with applications to the biological sciences. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):

Corequisite(s):

STAT 5606:

Biometry

5605: The normal distribution, estimation, hypothesis testing, simple linear regression, and one-way analysis of variance with applications to the biological sciences. 5606: Experimental design, nested and factorial analysis of variance, linear regression and correlation, and the use of SAS, with applications to the biological sciences. Knowledge of CMS required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5615:

Statistics in Research

5615: Concepts in statistical inference, including basic probability, estimation, and test of hypothesis, point and interval estimation and inferences; categorical data analysis; simple linear regression; and one-way analysis of variance. 5616: Multiple linear regression; multi-way classification analysis of variance; randomized block designs; nested designs; and analysis of covariance. One year of Calculus. CMS. I,III

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5616:

Statistics in Research

5615: Concepts in statistical inference, including basic probability, estimation, and test of hypothesis, point and interval estimation and inferences; categorical data analysis; simple linear regression; and one-way analysis of variance. 5616: Multiple linear regression; multi-way classification analysis of variance; randomized block designs; nested designs; and analysis of covariance. One year of Calculus and knowledge of CMS required. II,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5634:

Statistics for Behavioral Sciences

Basic statistical methods used in research in the behavioral sciences with emphasis on the applications of these methods. Descriptive statistics, correlational analyses, and intermediate inferential methods will be discussed. I,II,III

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5644:

Nonparametric Statistical Methods

Applications of rank-order statistics, sign statistics, the empirical distribution function, and runs to commonly occurring data structures. Emphasis on concepts, assumptions, comparisons to normal theory methods, and hands-on data analysis with the computer. Knowledge of CMS required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 3006 OR STAT 4706 OR STAT 5004 OR STAT 5606 OR STAT 5616)

Corequisite(s):

STAT 5664:

Applied Statistical Time Series Analysis for Research Scientists

Applied course in time series analysis methods. Topics include regression analysis, detecting and addressing autocorrelation, modeling seasonal or cyclical trends, creating stationary time series, smoothing techniques, forecasting errors, and fitting autoregressive integrated moving average models.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5616 OR STAT 5606

Corequisite(s):

STAT 5674:

Methods in Biostatistics

Statistical principles and methods required for effective clinical trial and clinical experiment design and analysis. Topics include graphical and

numerical exploratory data analysis, and comparative tests of categorical, ordinal, and continuous data, simple, multiple linear and logistic regression analysis, design of experiments and sampling theory. Additional topics include diagnostic tests, relative risk, odd ratio, and estimation of effective dose. Students will learn to properly interpret output from statistical software. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

STAT 5684:

Survival Analysis

Models and methods for time-to-event data with focus on biological and biomedical applications. Topics includes types of censoring and truncation; likelihood construction; survival function estimation; nonparametric two or more samples tests; Cox semiparametric regression, time-dependent covariates; regression diagnostics; competing risks; frailty model. Pre-requisite: Working knowledge of statistical software.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5044, STAT 5104, STAT 5114

Corequisite(s):

STAT 5694:

Longitudinal Data Analysis

Application and theory for longitudinal data analysis for both continuous and categorical response data, including the use of statistical software for data analysis. Topics include ANOVA, MANOVA, random-effects model, covariance pattern models, generalized estimation equations models, random-effects logistic regression models, and missing data in longitudinal studies. Pre-requisite: Working knowledge of statistical software.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5004, STAT 5104, STAT 5114

Corequisite(s):

STAT 5754:

Internship in Statistics

Full time, supervised internship experience at a company or government agency performing statistical analysis. May be repeated for a maximum of 3 hours toward an M.S. degree and 6 hours toward a Ph.D. degree.

Graduate standing in statistics and permission of department required.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5024

Corequisite(s):

STAT 5804G:

Fundamentals of Econometrics

Introduction to economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations, instrumental variables, panel data methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STAT 5904:

Project and Report

. I,II,III,IV,V

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

STAT 5924:

Graduate Seminar

Special topics in statistical theory and applications. May be taken for

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

STAT 5974:

Independent Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

STAT 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

STAT 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

STAT 6105:

Measure and Probability

Development of measure theoretic foundations of probability theory. 6105: sigma fields, probability, and general measures; random variables, measurability and distributions, integration, and expectation; product measures; Radon-Nikodym theorem and conditioning. 6106: Random variables and strong and weak laws of large numbers; characteristic functions, central limit theorem and martingales; stochastic processes and Brownian motion. 6105 partially duplicates Math 5225. Must be enrolled in PhD program. I
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture

Instruction Type(s): Lecture
Prerequisite(s): STAT 5104 OR MATH 4525
Corequisite(s):

STAT 6114:

Advanced Topics in Statistical Inference

Advanced course in the theory of inference for graduate students in statistics and other qualified graduate students. Develops foundations, sufficiency, information, estimation, hypothesis testing, invariance, and unbiasedness. II
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5114
Corequisite(s):

STAT 6124:

Stochastic Modeling and Inference

Data analyses and inferential techniques applied to data described by stochastic processes. Inferential techniques for Markov models, Poisson processes, point processes, birth/death processes, and cluster processes. Techniques for inference applied to both stationary and nonstationary processes. Relationships between deterministic partial differential equation models and stochastic models. Modeling applications in time series, spatial analyses, genetics, epidemiology, text mining, and other application areas.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5304, STAT 5314, STAT 5444
Corequisite(s):

STAT 6404:

Advanced Topics in Nonparametric Statistics

Topics of current interest in research for nonparametric theory and methods, using recent advanced texts and journal articles. Even years. II
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 5404, STAT 6114
Corequisite(s):

STAT 6424:

151 **Multivariate Statistical Analysis**

Foundations of multivariate analysis. Distribution theory of vectors and matrices, inequalities, limit theory, the structure of some multivariate location-scale parameter families, derived distributions, invariant distributions, the principle of invariance in estimation and testing for multivariate location and scale parameters, and robust aspects of normal-theory multivariate procedures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5504

Corequisite(s):

STAT 6474:

Adv Topics Bayesian Statistics

Advanced concepts and methods in Bayesian analysis, including specifying priors, large sample theory, adaptive rejection sampling, adaptive rejection metropolis Hastings sampling, reverse jump Markov Chain Monte Carlo, model selection, nonparametric and semiparametric Bayesian methods using nonparametric priors, and Bayesian survival models.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114, STAT 5514, STAT 5444

Corequisite(s):

STAT 6494:

Advanced Topics in Mathematical Statistics

Advanced treatment beyond standard course offerings in topics such as theory of inference, nonparametrics, sequential analysis, and limit theory. May be repeated for credit with different topics. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5114

Corequisite(s):

STAT 6504:

Experimental Design and Analysis II

Theoretical treatment of construction and analysis of various types of incomplete block and factorial designs. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5124, STAT 5204

Corequisite(s):

STAT 6514:

Advanced Topics in Regression

Advanced notions in modern regression techniques and diagnostics. The underlying theory and concepts associated with estimation methods for handling collinearity. Theory behind modern criteria for selection of candidate models. The development of single and multiple outlier and influence diagnostics. Odd years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5124, STAT 5514

Corequisite(s):

STAT 6574:

Response Surface Design and Analysis II

Advanced techniques and theory in response surface analysis and design. Robustness of designs. Thorough study of the notion of rotatability. Optimal design criteria and designs for estimating slopes of response surfaces. Mixture designs. Study of model misspecification. Even years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5574

Corequisite(s):

STAT 6634 (EDRE 6634):

Advanced Statistics for Education

Multiple regression procedures for analyzing data as applied in educational settings, including curvilinear regressions, dummy variables, multicollinearity, and introduction to path analysis. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5634

Corequisite(s):

STAT 7994:

Research and Dissertation

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FISHERIES AND WILDLIFE SCIENCES

Steve McMullin, Interim Head

Emeriti Faculty: Richard Neves; Michael Vaughan;

Professors: Paul Angermeier; James Fraser; Carola Haas; Eric Hallerman; Brian Murphy; Donald Orth; Dean Stauffer;

Associate Professors: Kathleen Alexander; C Dolloff; William Ford; Emmanuel Frimpong; William Hopkins; Yan Jiao; Sarah Karpanty; Marcella Kelly; Steve McMullin; James Parkhurst;

Assistant Professors: Leandro Castello;

Graduate Contact: smcmulli@vt.edu

Graduate Site: http://www.fishwild.vt.edu/pros_graduate.htm

The Department of Fish and Wildlife Conservation offers one of the leading programs of its type. The comprehensive curriculum covers fisheries and wildlife biology and ecology, habitat analysis, and human dimensions of natural resource science and management. Faculty specialties include endangered species management, cold water stream management, conservation genetics, tropic ecology, recycling aquaculture systems, wildlife physiology and ecotoxicology, human-wildlife interactions (including disease transmission), habitat analysis and management, geographic information systems, human dimensions, policy and administration. M.S. programs stress preparation for professional careers in public agencies and private organizations with fisheries and wildlife responsibilities. Doctoral programs stress preparation for research and leadership positions in public agencies and for university faculty positions.

SPECIAL FACILITIES

The department maintains facilities in Cheatham and Latham Halls for laboratory analysis, small-scale aquatic experiments, small-animal holding, computer analysis, and geographic information systems. Latest computer technology is available. The department collaborates frequently with the Conservation Management Institute, a research, survey, and outreach organization that grew out of the department's research program. Off campus aquaculture laboratories provide state-of-the-art facilities for endangered species aquaculture. Center Woods is an off-campus woodlot housing captive animal facilities for black bear and other animals. Most student research, however, is conducted in field locations; most projects are in Virginia and adjacent states, but current projects also occur in Alaska, South Dakota, Florida, and other states, as well as Belize, Indonesia, Botswana, and other countries.

Julian Cheatham Hall

Cheatham Hall houses the department's teaching and most of its

research laboratories, computer labs, faculty and graduate student offices, and administration. Key research spaces include laboratories focusing upon applied mammal and fish ecology, human dimensions of natural resources management, wildlife ecology, fish landscape ecology, wildlife behavioral ecology, threatened and endangered species, fluvial fishes and wildlife habitat and population analysis.

Latham Hall

Dedicated in 2006, Latham Hall provides well-outfitted laboratory space, environmentally controlled chambers, a necropsy room, and a walk-in freezer. Laboratory and research spaces include: the Fish Ecology and Management Laboratory, Wildlife Ecotoxicology and Physiological Ecology Laboratory, and the Ecological Research Archive.

Off-Campus Facilities

Two research groups, the conservation genetics and ecotoxicology groups, have research laboratories in the Corporate Research Center approximately two miles from the main Blacksburg campus. Off campus aquaculture laboratories provide state-of-the-art facilities for aquaculture of imperiled species, focusing on freshwater mollusk. Center Woods is an off-campus woodlot housing captive animal facilities for black bear and potentially for other animals. Most student research is conducted in field locations; most projects are in Virginia and adjacent states, but current projects also occur in Alaska, South Dakota, Florida, and other states, as well as Belize, Indonesia, Botswana, and other countries.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (550.0), Quantitative (600.0), Analytical (600.0)

We offer M.S. and Ph.D. degrees in Fisheries and Wildlife Science. Students specialize in either Fisheries or Wildlife Science. Coursework is tailored to the interest and needs of the students in consultation with the student's graduate committee. Successful applicants to our program usually have grade point averages above 3.5/4.0 (over the last 60 semester hours) and GRE scores at or above 156 (550 on old scale) in verbal and 148 (600 in old scale) in quantitative and analytical areas. Discipline-related experience is always a plus. Students with backgrounds in fisheries, wildlife, or natural resource management tend to be accepted at a higher rate than students with degrees in biology or environmental sciences. Although obviously there are many similarities between the fields, having a solid ecological background, an applied perspective, and background in policy and management is very helpful as you pursue an advanced degree in fisheries and wildlife. If you do not

have a B.S. in a resource management field, and you have the opportunity to take courses in natural resource management or fisheries and wildlife management, you would increase your chances of acceptance. You also might gain a better feel for whether you'd prefer enrolling in an ecology program or a fisheries and wildlife program. We accept students into the Ph.D. program only if they have completed an M.S. degree. We accept students only when a faculty member has financial resources to support stipend, tuition, and research expenses. Updated lists of available positions are posted on the department's webpage. Please check the list of available positions on a regular basis to see if there are opportunities for the upcoming semesters that match your research interests. Please be aware that we receive some funding opportunities at the last minute. It will be worth re-checking this web site periodically. You may want to check the list of faculty research and academic interests and correspond with a particular faculty member about likely openings in the next year or two. If you submit a formal application, you will be considered for any openings. All graduate students must conduct M.S. or Ph.D. research projects, in addition to course work chosen in consultation with an advisory committee. Research projects are designed in a student-written research working plan that is approved by the advisory committee. In almost all cases, students are funded on research contracts or teaching assistantships, both of which require substantial work outside of degree requirements. Most graduates are expected to satisfy certification requirements for either the American Fisheries Society or The Wildlife Society; this may require additional course work by students entering the program from other disciplines. All students must deliver at least two seminars and write a semi-technical manuscript about their research. Doctoral students are required to complete a diagnostic assessment of their competencies in five areas of knowledge within the first semester in residence and must teach at least one semester, regardless of funding source. All students are expected to participate in the professional and collegial life of the department and its professional specialty by attending seminars and professional meetings, participating in student organizations, and serving on departmental and professional committees.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (550.0), Quantitative (600.0), Analytical (600.0)

We offer M.S. and Ph.D. degrees in Fisheries and Wildlife Sciences. Students specialize in either Fisheries or Wildlife Science. Coursework is tailored to the interest and needs of the students in consultation with the student's graduate committee. Successful applicants to our program usually have grade point averages above 3.5/4.0 (over the last 60 semester hours) and GRE scores at or above 550 in verbal and 600 in quantitative and analytical areas. Discipline-related experience is always a plus. Students with backgrounds in fisheries, wildlife, or natural resource management tend to be accepted at a higher rate than students with degrees in biology or environmental sciences. Although obviously there are many similarities between the fields, having a solid ecological background, an applied perspective, and background in policy

and management is very helpful as you pursue an advanced degree in fisheries and wildlife. If you do not have a B.S. in a resource management field, and you have the opportunity to take courses in natural resource management or fisheries and wildlife management, you would increase your chances of acceptance. You also might gain a better feel for whether you'd prefer enrolling in an ecology program or a fisheries and wildlife program. We accept students into the Ph.D. program only if they have completed an M.S. degree. We accept students only when a faculty member has a sponsored contract to support stipend, tuition, and research expenses. Updated lists of available positions are posted on the department's webpage. Please check the list of available positions on a regular basis to see if there are opportunities for the upcoming semesters that match your research interests. Please be aware that we receive some funding opportunities at the last minute. It will be worth re-checking this web site periodically. You may want to check the list of faculty research and academic interests and correspond with a particular faculty member about likely openings in the next year or two. If you submit a formal application, you will be considered for any openings. All graduate students must conduct M.S. or Ph.D. research projects, in addition to course work chosen in consultation with an advisory committee. Research projects are designed in a student-written research working plan that is approved by the advisory committee. In almost all cases, students are funded on research contracts or teaching assistantships, both of which require substantial work outside of degree requirements. Most graduates are expected to satisfy certification requirements for either the American Fisheries Society or The Wildlife Society; this may require additional course work by students entering the program from other disciplines. All students must deliver at least two seminars and write a semi-technical manuscript about their research. Doctoral students are required to take a diagnostic exam within the first semester in residence and must teach at least one semester, regardless of funding source. All students are expected to participate in the professional and collegial life of the department and its professional specialty by attending seminars and professional meetings, participating in student organizations, and serving on departmental and professional committees.

GRADUATE COURSES (FIW)

FIW 5004:

Graduate Seminar

Advanced exploration of special topics in fisheries and wildlife, through literature reviews, guest speakers, student/faculty presentations, and small group projects. Topics and format vary depending on interests of faculty and graduate students. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5014:

Constructing Sustainability

Synthesize ecological, economic, and social dimensions of sustainable

and resilient systems. Examine history, theory, current status, and future prospects of sustainability and resiliency as organizing principles for natural resource management professions. Situate science, policy, professional and civic institutions in sustainability efforts. Analysis sustainable and resilient bio-cultural systems. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5114:

Fisheries and Wildlife Conservation Genetics

Population genetics of terrestrial and aquatic animals as applied to fisheries and wildlife management, endangered species management, and ecosystem protection. Discussion of genetic variability and analytic techniques, population genetic processes, and practical applications. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5174G:

Advanced Fisheries Management

History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management objectives. Synthesis of fish population dynamics and manipulation, habitat improvement, and human management to achieve objectives. Case studies of major fisheries. Pre-requisite: Graduate Standing required.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FIW 5214:

Vertebrate Population and Habitat Analysis

Application of quantitative methods to data collected on wild vertebrates. Philosophy and principles of study design and hypothesis testing. Habitat sampling design and analysis for terrestrial and aquatic systems. Population estimation including indices, distance measures, open and closed-population mark-recapture estimators. Current approaches to

estimating survival and reproductive parameters. Integrating population and habitat data to assess resource preference. Principles of habitat modeling and community measures. Even Years. Pre: an introductory graduate level statistics class. I.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FIW 4444

Corequisite(s):

FIW 5224:

Wildlife Population Dynamics

Advanced course in wild animal population dynamics with emphasis on research concerning theories of population regulation. Discussion topics include characteristics of population growth, age and sex composition in relation to population growth, general features of population fluctuations, and natural control and regulation of bird and mammal populations. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIW 4414

Corequisite(s):

FIW 5314:

Vertebrate Population Ecology and Management

Wild animal population and evolutionary ecology. Historical and current research concerning theories of population growth, population regulation, spatially structured populations, evolution of life histories, and the scaling up of population concepts to community and ecosystem applications. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5334:

Vertebrate Physiological Ecology

Physiological and behavioral adaptations of vertebrates inhabiting extreme environments. Artic, desert, cave, high altitude, deep sea, tidal pools, estuarine. Pre: Introductory course in physiology (FIW 2314, Biol 3404 or equivalent). Graduate standing required. Even years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5414:

Endangered Species Management

History, philosophy, and practice of endangered species management with emphasis on management in the United States. Biology of extinction, rationale for preservation, endangered species legislation, status surveys, management goals, habitat protection, recovery plans. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIW 4414 OR FIW 4614 OR BIOL 4404

Corequisite(s):

FIW 5454G:

Advanced Vertebrate Pest Management

Management of vertebrate pest species; causes and prevention of damage by vertebrate pest species to food and fiber plants, animal production, structures, human transportation systems, and health of human and domestic animals. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5464G:

Advanced Human Dimensions of Fisheries and Wildlife

Values, attitudes and opinions of people towards 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. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5514:

Fish Population Dynamics and Modeling

Theory and application of fish population models for managing recreational and commercial fisheries. Estimation of basic fish population statistics (abundance, mortality, growth). Development and application of models for age-structured populations, bioenergetics, growth, stock-recruitment, yield, predation, and competition. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FIW 4714

Corequisite(s):

FIW 5534G:

Advanced Wetland Ecology and Management

Introduction to the variety of wetland systems found in North American, with emphasis 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. Objective of management and techniques used to protect and/or manipulate wetland systems for wildlife and other human needs. Graduate Standing required.

Credit Hour(s): 0 TO 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FIW 5624G:

Advanced Marine Ecology

Marine organisms; biological, ecological, chemical and physical processes of marine ecosystems in open-sea, coastal, and benthic environments; research methods and models in marine ecosystem stimulation; fisheries in a dynamic ecosystem; human interference and conservation. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5714G:

Advanced Fisheries Management

History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management objectives. Synthesis of

human management to achieve objectives. Case studies of major fisheries. Pre-requisite: Graduate Standing required.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FIW 5734:

Fisheries and Wildlife Planning

Use of logic, software packages, and programming skills necessary to effectively create and apply computer programming languages as needed in the discipline of Fisheries and Wildlife Sciences. Instruction in two programming languages, one to learn beginning programming skills and a second to learn more advanced features such as complex, built-in functions. Construction and use of a graphical user interface.

Application of computer programming to problems in Fisheries and Wildlife Sciences. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FIW 4414

Corequisite(s):

FIW 5744:

Sim Modeling Fish & Wildlife

Application of simulation models to problems in Fisheries and Wildlife Sciences. Modeling in the context of cybernetics. Model theory, terminology, creation, exploration, and testing. Present models to technical and non-technical audiences. Critically examining classic and current modeling literature in fisheries and wildlife sciences. Population dynamics models including harvest, stock assessment, and population of viability.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (FIW 4414 (UG) OR FIW 4414), FIW 5734

Corequisite(s):

FIW 5814:

Stream Habitat Management

Application of stream ecology, fish biology, hydrology, and hydraulics to the protection, restoration, and enhancement of stream habitats and fauna. Major emphasis on stream habitat evaluation, regulated stream

flow, biotic, integrity, and watershed management. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BIOL 4004

Corequisite(s):

FIW 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FIW 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FIW 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

FIW 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):
Corequisite(s):

FIW 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

FIW 6004:

Topics: Fisheries & Wildlife

Readings and discussion in a specific area of fisheries and wildlife conservation. Topic will vary and course may be taken for credit more than once. Background in fisheries or wildlife required. Variable credit course. Graduate standing required. I, II.

Credit Hour(s): 0 TO 12
Lecture Hour(s): 0 TO 12
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

FIW 6114:

Applied Conservation Genetics

Use of analytical tools and software packages to characterize population genetics of terrestrial and aquatic animals for application in fisheries, wildlife, and endangered species management. Population genetic processes and theory, laboratory methods for screening molecular markers (mitochondrial and nuclear DNA markers), analysis of genetic data using various computer software programs, and interpretation of statistical results.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): FIW 5114
Corequisite(s):

FIW 6214:

Advanced Habitat Analysis

Conceptual and applied aspects of analysis of wildlife- habitat relationships. Modeling population response as a function of habitat characteristics. Model selection and evaluation using R2, Akaike's Information Criterion, Bayesian Information Criterion, and concordance. Use-availability analysis with resource-selection functions. Analyzing habitat patterns with multivariate approaches including Principal Components Analysis, Discriminant Function Analysis, and Cluster Analysis. Understanding of SAS required. Even years. I

Credit Hour(s): 0 OR 3
Lecture Hour(s): 0 OR 2
Instruction Type(s): Lab, Lecture
Instruction Type(s): Lab, Lecture
Prerequisite(s): FIW 5214, STAT 5615, STAT 5616
Corequisite(s):

FIW 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

FIW 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

FORESTRY

Janaki Alavalapati, Head

Professors: Janaki Alavalapati; Gregory Amacher; Wallace Aust; Harold Burkhart; Thomas Fox; Robert Hull; Stephen Schoenholtz; John Seiler; Bradley Sullivan; Randolph Wynne;

Associate Professors: Michael Bolding; Amy Brunner; Carolyn Copenheaver; John McGee; John Munsell; Stephen Prisley; Philip Radtke; Marc Stern; Phillip Wiseman;

Assistant Professors: Kelly Cobourn; Susan Day; Jason Holliday; Kevin McGuire; Michael Sorice; Brian Strahm; Valerie Thomas; Robert Thomas;

Affiliated Faculty: Jeffrey Marion;

Julian N. Cheatham Professor of Forestry: Gregory Amacher;

University Distinguished Professor: Harold Burkhart;

Shelton H. Short, Jr., Professor of Forestry: John Seiler;

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Virginia Tech's Department of Forest Resources and Environmental Conservation is one of the leading programs in natural resource management in the United States. Our teaching and research focus on the latest applications to uncover the science needed to manage forests and other natural resources. Our programs are diverse and approach critical natural resource issues from many disciplinary perspectives. From protected areas management and economic policy to forest soil productivity, urbanization, and genomics, we seek to discover new knowledge and technology to address the global challenges to come.

SPECIAL FACILITIES

Virginia Tech's Department of Forest Resources and Environmental Conservation has over 2,000 acres of forested land for research use, as well as state-of-the-art laboratories and greenhouses. Facilities are primarily located on or near campus; at the Reynolds Homestead in Critz, Virginia; and at the Institute for Advanced Learning and Research in Danville, Virginia. Julian N. Cheatham Hall Serving as the primary campus building for forestry and natural resources studies, Cheatham Hall houses exceptional teaching and research laboratories, computer labs, faculty and graduate student offices, and administration. Forestry laboratories include: Dendrochronology & Ecology Laboratory Human Dimensions Analysis Laboratory Urban Forestry Laboratory Dendrology Teaching Laboratory Forest Soils Teaching Laboratory Latham Hall Dedicated in 2006, Latham Hall provides greatly-expanded and fully-outfitted laboratory space, one-of-a-kind growth chambers that allow study of large trees, soil and plant material preparation areas, conference rooms, and faculty offices. Laboratory and research space includes: Forest Ecophysiology Laboratory Forest Molecular Genetics and Biotechnology Laboratory Forest Tree Nutrition Laboratory Forest Soils & Hydrology Laboratory Water Resources Center Laboratory Plant Preparation Facility Soil Preparation Facility Six full-size growth chambers Fishburn Forest A 1,353-acre demonstration forest of the Appalachian hardwood and mixed pine-hardwood type, the College of Natural Resources and Environment's Fishburn Forest provides ample space for laboratories and research in the Ridge and Valley physiographic region. It is located 10 minutes from the Blacksburg campus. Reynolds Homestead Forest Resources Research Center The Reynolds Homestead Forest Resources Research Center is a 710-acre research unit located in the Virginia Piedmont approximately 70 miles from Blacksburg. It is equipped with a laboratory, greenhouse, slat house, nursery bed, ample field space, and is well staffed for program support. Center for Environmental Applications of Remote Sensing (CEARS) The CEARS lab is a state-of-the-art research facility developed by several Virginia Tech researchers from multiple departments who have formed partnerships with other industries, institutions, and governments to solve a wide array of environmental problems. CEARS was established in 1997 as a NASA Center of Excellence in applications of remote sensing to regional and global integrated environmental assessments. It is Virginia Tech's focal point for interdisciplinary research, instruction, and outreach focused on remote sensing applications. CEARS researchers have extensive expertise with a wide variety of data types (e.g., active and passive microwave, multispectral, hyperspectral, lidar, aerial photographs) and application areas (e.g.,

temperate and tropical forestry, limnology, ecological modeling, marine biology, environmental monitoring, urban ecology, carbon sequestration, tropical biodiversity assessment, rangeland management, invasive species, fire fuel loading). The CEARS laboratory is physically and administratively housed within the College of Natural Resources and Environment but is shared with other colleagues and constituencies, both on campus and off. Virginia Water Resources Research Center (VWRR) VWRR was established at Virginia Tech in 1965 by the U.S. Congress as one of the nation's 54 water institutes and is affiliated with the College of Natural Resources and Environment. The center's mission is to offer research and educational opportunities to water scientists and students and provide citizens and government leaders with water science information. Institute for Advanced Learning and Research The Departments of Horticulture and Forest Resources and Environmental Conservation operate a state-of-the-art tissue culture research laboratory at the Institute of Advanced Learning and Research in Danville, Virginia. Greenhouses The university has ample greenhouse facilities located on the Virginia Tech campus. FREC maintains a soil and plant preparation facility as part of the greenhouse complex. In addition, FREC faculty have access to a fully-automated greenhouse facility in nearby Newport, Virginia, as well as greenhouses at the Reynolds Homestead. Harvesting Research Laboratory The department's harvesting laboratory is located in Blacksburg adjacent to the Virginia Tech campus. This 2,400-square-foot facility has a fully-equipped machine shop for fabricating new machine designs and supporting the skidders, loader, trucks, and other equipment used in field research. Urban Horticulture Center The Urban Horticulture Center (UHC) of Virginia Tech, located about three miles from campus, was established in 1989. The UHC is a facility of the Horticulture Department but also provides facilities for closely-related research projects, primarily in urban forestry. The center includes field plots, unheated poly houses, a pot-in-pot growing area, equipment storage, walk-in cooler, and office space.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

The department offers three degrees: Master of Forestry (M.F.), Master of Science (M.S.) in Forestry and Forest Products, and Doctor of Philosophy (Ph.D.) in Forestry and Forest Products. The M.S. and Ph.D. degrees require students to prepare a thesis or dissertation, and considerable time spent working for these degrees is devoted to research. The M.F. degree is a professional, non-research degree for those who wish to expand their post-baccalaureate education. Master of Forestry The M.F. is a non-research degree intended to serve the needs of (1) those who have a prior forestry degree and who wish to enhance their knowledge and skills or (2) those who have no previous degree in forestry. In addition to formal course work at the graduate and senior undergraduate levels that is commensurate with the objectives of the student's degree program, a substantive paper worth three to six hours of academic credit is required. A minimum of 30 credit hours in formal

course work, inclusive of hours credited towards the degree paper, must be passed with a minimum QCA of 3.0 for courses in the program of study. For students entering the M.F. program without prior forestry education, a minimum of 18 credit hours in forestry core courses must be completed in addition to the usual M.F. requirements. The 18 core credit hours must consist of Forest Biology and Dendrology (FOR 2314, 2 credits), Dendrology Lab (FOR 2324, 1 credit), Survey of Forest Ecology and Management (FOR 3364, 3 credits), plus a total of 12 credit hours in forestry courses--of which 9 credit hours must be at a 3000 level or higher. The M.F. student must pass a comprehensive oral examination covering his/her course work and the degree paper. All Graduate School requirements apply as to the nature and timing of the candidate's final examination. Master of Science The M.S. is a research-based degree. Students work closely with a faculty advisor and graduate committee on original research. Advanced coursework is expected in the areas of expertise required to complete the research project. Students complete a thesis and are expected to publish their research results in peer-reviewed scientific journals at the completion of their degree. Graduates are prepared to continue their professional careers or undertake further study through a Ph.D. program. All Graduate School requirements apply regarding the number of credits and level of courses required on a student's Plan of Study. M.S. students must complete a research working plan by the end of the second academic semester. Guidelines for the preparation and submittal of the working plan are listed in the College of Natural Resources and Environment (CNRE) Graduate Program Procedures. M.S. students must pass a final exam. The examination will be a defense of the thesis and an assessment of the student's understanding of appropriate forestry-related subjects.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

The department offers three degrees: Master of Forestry (M.F.), Master of Science (M.S.) in Forestry and Forest Products, and Doctor of Philosophy (Ph.D.) in Forestry and Forest Products. The M.S. and Ph.D. degrees require students to prepare a thesis or dissertation, and considerable time spent working for these degrees is devoted to research. The M.F. degree is a professional, non-research degree for those who wish to expand their post-baccalaureate education. Doctor of Philosophy Each Ph.D. student must complete a minimum of 90 credit hours of graduate study and a dissertation. The Plan of Study must meet minimum Graduate School requirements; in addition, a student's advisory committee may add specific requirements needed for an individual student's academic development. Ph.D. students must complete a research working plan by the end of the third academic semester. Guidelines for the preparation and submittal of the working plan are listed in the College of Natural Resources and Environment (CNRE) Graduate Program Procedures. All Ph.D. students in the Department of Forest Resources and Environmental Conservation must demonstrate minimum competency in statistics (see CNRE Graduate Program Procedures for requirements). Doctoral students may be required to take a qualifying exam. The exact nature of the exam is determined by faculty within the student's chosen discipline. The purposes of this examination or assessment are to (1) evaluate the

student's comprehensive knowledge in his/her field or study, (2) identify any deficiencies in the student's background and recommend supplementary course work or self-study improvements, and (3) evaluate the student's ability to successfully complete the doctoral degree. A required preliminary exam, oral and/or written, is conducted by the student's advisory committee. This exam is comprehensive in nature and is intended to test a student's ability to integrate, synthesize, and apply concepts, facts, and techniques in solving new and complex problems associated with forest management and use. The student may be tested on any aspect of forest science, the philosophy of science, and research methodology. The final exam is primarily a defense of the dissertation, but other areas of science may be included. Ph.D. students are expected to publish their research results in peer-reviewed scientific journals at the completion of their degree.

GRADUATE COURSES (FOR)

FOR 5004:

Graduate Seminar

Special topics, critical reviews, and discussions of pertinent literature throughout a wide range of subject areas in forestry. May be repeated.

I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5014:

Constructing Sustainability

Synthesize ecological, economic, and social dimensions of sustainable and resilient systems. Examine history, theory, current status, and future prospects of sustainability and resiliency as organizing principles for natural resource management professions. Situate science, policy, professional and civic institutions in sustainability efforts. Analysis sustainable and resilient bio-cultural systems. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5104 (GEOG 5104):

Seminar in Remote Sensing & Geographic Information Systems

Interdisciplinary seminar devoted to current research in the fields of remote sensing, Geographic Information Systems, and related topics.

Seminars, workshops, and presentations conducted by students, faculty, and visitors. Pre: Graduate standing.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5114G:

Advanced Information Technologies for Natural Resource 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 application will be discussed.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 2214 (UG) OR GEOG 2314 (UG)

Corequisite(s):

FOR 5124:

Law of Natural Resource Management

Seminar-styled graduate course will explore the legal principles underlying the management of the various natural resources of the United States. Emphasis will be placed on understanding the evolution of the current state of the law, as well as on the resultant management implications on both private and public lands. Topics covered will include: public lands, wildlife, preservation and recreation, range, minerals, timber, water, and a discussion of the legal aspect of ecoterrorism. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5134:

Environmental Conflict Management

Seminar-styled course will develop and explore theories and practical approaches to understanding and managing modern environmental conflicts, with an emphasis on the processes and structures unique to the United States. Causes, controls, and potential remedies for managing the intense conflicts routinely associated with natural resource

management and environmental regulation. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5144:

Hillslope and Watershed Hydrology

Physical concepts of hydrological processes that affect age, origin, and flowpaths of water from hillslope to watershed scales.

Analysis of current and historical research methods. Hydrological science as an interdisciplinary topic. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5154:

Hyperspectral Remote Sensing

Theory of spectroscopy and spectrometry from portable spectroradiometers to airborne and spaceborne hyperspectral sensors as relevant to natural resource applications, including vegetation species identification and vegetative health, soil and peat properties, mineral and geothermal characteristics, and water applications. Practical investigation of research tools and techniques used to analyze hyperspectral data. Pre-requisite: Graduate Standing Required

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FOR 5214:

Advanced Forest Inventory

An advanced course in forest inventory and sampling. Topics include the foundations of point, plot, and probability proportional to prediction sampling, application of Bayesian and James-Stein methods, and unequal probability sampling in the forest setting. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FOR 3215 OR FOR 3216 OR STAT 4524

Corequisite(s):

FOR 5224:

Forest Biometry

Theory and practice involved in the measurement and modeling of the growth and yield of forest trees and stands I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FOR 3215, FOR 3216, STAT 5606, STAT 5616

Corequisite(s):

FOR 5254:

Remote Sensing of Natural Resources

Philosophy and rationale of remote sensing as a part of the resource management process; comparisons of analogic and digital sensors; sensor selection and proper use; accuracy assessment; signature development; and identification of factors which affect the quality of remotely sensed information. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 4214 OR GEOG 4354

Corequisite(s):

FOR 5264 (GEOG 5364):

GIS Applications in Natural Resource Management

Acquiring and using publicly available natural resources data sources. Methods and algorithms for terrain modeling and landscape metrics. Evaluation of the impacts of data errors and variability on analysis results, including sensitivity analysis of GIS-based resource assessments. Special issues related to temporal data and the management of natural resources information systems. I.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 4214 OR GEOG 4084

Corequisite(s):

FOR 5334:

Plant Water Relations

Properties and status of water in the plant and thermodynamics in relation to water and solute movement; measuring water deficits and

drought tolerance; and transpiration and stomatal action. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FOR 5354:

Advanced Forest Soils

Current topics in forest soils with emphasis on soil-site relationships, managing soil water, tree roots and nutrient uptake, diagnosis and correction of nutrient deficiencies, effect of atmospheric deposition on forest soils, and modeling and simulation of nutrient and water movement in forest soils. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 4354

Corequisite(s):

FOR 5354G:

Advanced Forest Soils and Hydrology

Principles of forest soils and hydrology and applications of forest management. Forest soil development, relationships of soils and hydrologic properties to sustainable forest and watershed management. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FOR 5374:

Advanced Forest Ecology

Advanced topics in forest ecology, including: forest populations, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes, spatial heterogeneity, and hierarchy issues in ecology. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 3314, MATH 2016, STAT 5606, STAT 5616

162 Corequisite(s):

FOR 5374G:**Advanced 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. Data analysis, interpretations, and report for field trips are required for graduate credit. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FOR 5384:**Forest Biology and Ecology for Educators**

This online course is designed to provide educators with an understanding of the specifics of forest ecology and tree biology. Topics include identification of approximately 80 commonly found tree species, tree growth and development, woody plant reproduction and propagation, carbon and water uptake, dormancy and coldhardiness, site productivity and forest succession, forest soils, and silvicultural practices in managed forests. This class is offered online during a 10 week period that extends over both Summer I and II sessions. This course is not available to graduate students enrolled in Forestry programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FOR 5415:**Advanced Forest Resource Management and Economics**

5415: Application of microeconomics to solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory, and interregional and international trade in forest products. 5416: Impacts of economic and physical variables upon forest appraisal and management decisions. Valuation of nonmarket goods and economics of multiple-use. Application of operations research tools in evaluating forest management alternatives in public and private forest planning. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FOR 3414, FOR 4424

Corequisite(s):

FOR 5416:**Advanced Forest Resource Management and Economics**

5415: Application of microeconomics to solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory, and interregional and international trade in forest products. 5416: Impacts of economic and physical variables upon forest appraisal and management decisions. Valuation of nonmarket goods and economics of multiple-use. Application of operations research tools in evaluating forest management alternatives in public and private forest planning. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FOR 3414, FOR 4424

Corequisite(s):

FOR 5454G:**Advanced Urban Forest Management and Policy**

Planning, administration, financing, and management of trees, forests, and green space associated with urban areas and the urban/rural interface. Includes a study of the social needs and values of urban situations; urban tree/forest resource assessments; tree and vegetation ordinances; development, financing and management of tree maintenance programs; community involvement, public relations, and urban forestry education programs. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FOR 5464:**Social Science Research Methods in Natural Resources**

Social science research design and methods for students studying natural resource management. Addresses the unique and interdisciplinary nature of social science research related to complex natural resource problems. Guides students through the development of

research questions into detailed research proposals that address human dimensions of natural resource management. Students' own research topics will provide examples for in-class discussion of research design.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

FOR 5474 (HORT 5474):

Adv Stud in Urban For Ecosys

The nature and dynamics of urban ecosystems with emphasis on the role of urban forests. Examines the interactions of urban forests with the built environment at multiple scales and from multiple disciplinary perspectives. Management influence on ecosystem processes and approaches to estimating urban forest ecosystem services from urban cores to pre-urban development. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FOR 5494:

Natural Resource Research Procedures

An examination of concepts and philosophies of science and research as applied to forestry and related renewable natural resource research programs. Emphasis is on scientific procedure, ethics, and responsibility.

Attention is also paid to the specifics of establishing research projects, contracts, and grants and carrying them out. Consent required. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5614:

Forest Products Marketing and Management Strategies

Examination of forest products markets, industry structure, distribution channels, and strategic management trends. Case studies demonstrate the impact of these factors on decision-making in the forest products industry. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FOR 4614 OR FOR 3424

Corequisite(s):

FOR 5714:

Environmentally Sensitive Harvesting

Timber harvesting practices and its relationship with the environment. Comparing current USA harvesting practices and regulations with other timber producing countries. Overview of best management practices; including the role of federal, state and non-governmental agencies. Forest product certification and environmental management systems; such as Sustainable Forestry Initiative, Forest Stewardship Council and International Standards Organization. Techniques for measuring impacts on the environment. Harvesting for non- timber goals, such as wildlife, aesthetics, reduction of fire risk and ecosystem management. Low impact harvesting systems; modifications of existing systems; helicopter, cable, cut-to-length and horse logging. Graduate standing required. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5714G:

Advanced Harvesting Systems Evaluation

Advanced principles and techniques for evaluating harvesting machines and systems design, application, productivity, and financial performance. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FOR 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

FOR 5904:**Project and Report**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FOR 5954:**Study Abroad**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FOR 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

FOR 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FOR 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FOR 6214:**Forestry Lidar Applications**

Theoretical underpinning of established and emerging research using light detection and ranging (lidar) technology for forestry applications including detailed terrain mapping and digital elevation models, canopy height modeling, prediction of forest biophysical parameters, forest physiology and the canopy light regime, watershed mapping and stream modeling, ecological modeling, landscape classifications, and wildlife habitat. Advanced research tools and techniques used to analyze lidar data for different applications. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 5254, FOR 5264, GEOG 5034

Corequisite(s):

FOR 6984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FOR 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

GEOGRAPHY

Laurence Carstensen, Head

Professors: James Campbell; Laurence Carstensen;**Associate Professors:** Andrew Ellis; Lisa Kennedy; Korine Kolvras; Lynn Resler;**Assistant Professors:** Timothy Baird; Luke Juran; Robert Oliver; Yang Shao;**General Contact:** geog@vt.edu**Graduate Site:** <http://geography.vt.edu/PROGRAMS/graduate.htm>

The graduate program in geography consists of an MS degree in Geography and a PhD. degree in Geospatial and Environmental Analysis. The MS degree develops specialists for academic, agency and industry positions though emphasis on: Making appropriate use of methods for geographic inquiry to determine, to analyze, and to interpret spatial and temporal patterns and processes Identifying debates and gaps in the current literature to define an original research question Conducting research, collecting primary or secondary data, defending, and presenting their findings in publishable form At the doctoral level, the emphasis is on preparation for research careers with agencies or in academia as: students will demonstrate advanced proficiency in geospatial analysis in an interdisciplinary environment students will conduct and defend independent research that contributes to the literature students will identify and apply appropriate statistical methods for specific research questions

SPECIAL FACILITIES

The department is housed in Major Williams Hall on the upper quad of the campus. The department occupies the entire first floor of the building with faculty offices and laboratory space.

Biogeography Laboratory

Two Biogeography Laboratories offer advanced facilities for the study of recent and long-term environmental history and vegetation change through analysis of lake sediment and/or tree rings. Equipment resources include refrigerated storage, computers, several Leica compound microscopes with digital imaging capability used in paleoecological research, a Colinvaux-Vohnout Sediment Coring system, Fume Hood, isotemp Furnace, and a Velmex tree-ring measurement system used in dendrochronological analysis.

Geospatial Laboratory

The Department's GIS Laboratory offers 18 Windows 7 workstations for classes and for research, including specialized systems for GIS, cartography, and remote sensing. Software packages include the complete suite of ArcGIS, ArcEngine, Surfer, Python, Visual Studio, Trimble GPS Pathfinder, ERDAS IMAGINE, ENVI/IDL, and eCognition.

Physical Geography Laboratory

The Physical Geography Lab includes equipment for soil sampling, sample desiccation and microscopic viewing.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (500.0), Quantitative (500.0), Analytical

The MS program in geography emphasizes developing professional

competence in the tools, substance, methodology, and theory of the discipline. Thesis and non-thesis options in the 30 semester hour program prepare students for a variety of careers in teaching, research and planning organizations, business and government.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (550.0), Quantitative (550.0), Analytical

The Geospatial and Environmental Analysis PhD. degree is housed in the College of Natural Resources and Environment and the Department of Geography is the home to about 60% of its students. The degree requires that students become proficient in the use of Geographic Information Systems and Remote Sensing and that their research make use of those tools in environmentally oriented research.

GRADUATE COURSES (GEOG)

GEOG 5014:

Geographic Theory and Research

Study of how physical geography, human ecological concerns, and the spatial perspective have been synthesized into a unified academic discipline. Formulation of geographic research problems, including collection, organization, and analysis of geographic data. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5024:

Area Studies Methods

Introduction to recent theories and methods in history, foreign languages and literary studies, and geography with a focus on issues that have facilitated exchanges between the three disciplines. Practical aspects of Area Studies research are highlighted with particular reference to Latin America, the Caribbean, and Europe. The formulation of research problems using interdisciplinary approaches is given special attention. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5034:

Analysis of Spatial Data

Methods of describing and analyzing spatial distributions, including spatial autocorrelation, quadrat analysis, trend surface analysis, and methods of map comparison. Applications to student research problems.

II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5074G:

Advanced Medical Geography

Geographic patterns of disease and health care at various scales. Ecological, holistic approach to health problems emphasizes interrelationships of population-habitat-culture. Mapping of disease patterns and health services delivery and utilization. Field experience included. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5084G:

Intermediate Geographic Information Systems

Use of automated systems for geographic data collection, digitization, storage, display and analysis in graduate research. Basic data flow in GIS applications. Overview of GIS applications. Developing research methodology using GIS. Group projects to develop proficiency in the use of current GIS software. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5104 (FOR 5104):

Seminar in Remote Sensing & Geographic Information Systems

Interdisciplinary seminar devoted to current research in the fields of remote sensing, Geographic Information Systems, and related topics.

Seminars, workshops, and presentations conducted by students, faculty, and visitors. Pre: Graduate standing.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5124:

Aerial Photointerpretation and Analysis

Principles, history, and methods of aerial photographic interpretation. Introduction to photographic systems and application to aerial photography. Human dimension to photointerpretation. Applications to varied fields of knowledge such as land-use mapping, earth sciences, forestry, agriculture, history and archaeology, and military and strategic studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOG 4354, FOR 4214

Corequisite(s):

GEOG 5154:

Hyperspectral Remote Sensing

Theory of spectroscopy and spectrometry from portable spectroradiometers to airborne and spaceborne hyperspectral sensors as relevant to natural resource applications, including vegetation species identification and vegetative health, soil and peat properties, mineral and geothermal characteristics, and water applications. Practical investigation of research tools and techniques used to analyze hyperspectral data. Pre-requisite: Graduate Standing Required

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5214:

Health and the Global Environment

Examination of human-environment relations in the context of health and disease using a global perspective. Investigation of dynamic interactions

biological, cultural, political, and economic environments, in relation to disease. Analysis of geographic variations in health, disease, and health care delivery, including differences between developed and developing regions and within a variety of human and physical environments.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5224:

Tourism and Sustainability

Examines the role of natural and cultural sustainability in international tourism. Theoretical perspectives on conceptualizing and operationalizing sustainable tourism. Case studies drawn mainly from low-income and tropical climates. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5234:

Human Impacts on the Environment

Human impacts on patterns and processes in the physical environment, including hydrology, soil and landforms, climate and atmosphere, and biota. Social and cultural processes associated with human impacts. Analysis of causes of geographic variations in impacts on environment, including differences between developed and developing countries, arid and humid environments, and islands and continents. Historical and contemporary transformations in the environment considered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5244:

Advanced Soil Interpretation Using GIS and DSS

Use of Geographic Information System (GIS) software to compile digital maps, imagery, and natural resource data and decision support systems (DSS) to produce interpretative maps from digital soil data as part of a research proposal and project. Field trip and class attendance required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CSES 4124, GEOG 4084 OR BSE 4344 OR CEE 4204

Corequisite(s):

GEOG 5264:

Global Change and Local Impacts

All jurisdictions, national, regional, or local, function in an interconnected global market. Understanding the structure and interactions within that global market and the impacts therein is the focus of UAP 5264.

Thematic topics include a review of welfare state functions, privatization, decentralization, and nonprofit organizations and their relation to global market dynamics. Upon completion of the course, students will have an understanding of how global forces influence local areas and how local leaders have developed strategies to cope with their position in an increasingly global market. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5314:

Advanced Spatial Analysis in Geographic Information Systems

Theory and application of geographic information systems. Spatial data handling and analysis to facilitate decision-making through the communication of geographic information. Development of such systems from existing data sources using both packaged and student produced software systems. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): GEOG 4084

Corequisite(s):

GEOG 5344:

The Globalization of Nature

The transport of species including plants, animals, and microbes, around the world by people in both historical and recent times. The causes, consequences, and global patterns of biological invasions. The impacts of invasive species on physical and biotic systems, including the human condition, will be a major theme, along with discussion of current high-tech mitigation strategies. Societal attitudes toward "exotic" and

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5354:

Advanced 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. Field project and report. Review of current research literature.

Pre-Requisite: Graduate Standing Required

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5354G:

Advanced 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. Field project and report. Review of current research literature.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5364 (FOR 5264):

GIS Applications in Natural Resource Management

Acquiring and using publicly available natural resources data sources.

Methods and algorithms for terrain modeling and landscape metrics.

Evaluation of the impacts of data errors and variability on analysis results, including sensitivity analysis of GIS-based resource assessments. Special issues related to temporal data and the management of natural resources information systems. I.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): FOR 4214 OR GEOG 4084

Corequisite(s):

GEOG 5374G:

Adv Remote Sensing & Phenology

This course focuses on the analysis of the spatio-temporal of the vegetated land surface as observed in satellite images. Phenological events, such as the first openings of leaf and flower buds, are good indicators of the impact of local and global climate change. The focus of this course will be on satellite image time series used in the derivation of land surface phenology, the appearance and development of phenology other global regions, and the methods developed for the monitoring of phenology with satellite imagery. A major theme will be causes of spatio-temporal changes of phenological events and the effect of global climate change. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GEOG 5354

Corequisite(s):

GEOG 5384:

Prog for Geo Info Sys

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5394G:

Web Mapping

Use of web mapping technologies for geographic data collection, storage, analysis, and display. Web mapping topics include history and context, spatial data infrastructures, hardware and software architectures, Open Geospatial Consortium standards, mapping API's, virtual globes, user-centric design, web cartography. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

169 Corequisite(s):

GEOG 5424:**Topics in Political Geography**

Territorial basis of political systems, political processes, and political behavior from local to global scales; evolution of contemporary political geographic patterns, territorial divisions, and process of partitioning the earth. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5434:**Topics in Regional Geography**

Selected topics concerning development and change in a specific region such as Sub-Saharan Africa, the Caribbean, Appalachia, or the European Community. Spatial, ecological and historical perspectives, including examination of pertinent social theory. Can be taken up to three times provided the subject material is different.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5444:**Topics in Physical Geography**

Investigation of selected advanced topics in physical geography, such as the history of inquiry in the field of physical geography, systems theory, the scientific method in physical geography, scale, complexity, environmental change, and problems of explanation and extrapolation. Even years, May be repeated for credit for a maximum of 9 credit hours with different content. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5654 (SOC 5654):**The Global Division of Labor**

Theory and research on the globalization of the division of labor during the recent past as well as over the past several centuries. Examines the

development of the capitalist world-system including the role of technological forces; the roles of transnational corporations and states in the global economy; the effects of globalization on work and quality of life in the U.S., other developed countries, and the Third World; analyses of globalization in the manufacturing and service sectors; and possible solutions for problems associated with globalization.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5764G:**Advanced International Development Planning and Policy**

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.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5894:**Final Examination**

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GEOG 5904:**Project and Report**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

GEOG 5954:**Study Abroad**

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

GEOG 5974:

Independent Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

GEOG 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

GEOG 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

GEOG 6214:

Forestry Lidar Applications

Theoretical underpinning of established and emerging research using light detection and ranging (lidar) technology for forestry applications including detailed terrain mapping and digital elevation models, canopy height modeling, prediction of forest biophysical parameters, forest physiology and the canopy light regime, watershed mapping and stream modeling, ecological modeling, landscape classifications, and wildlife habitat. Advanced research tools and techniques used to analyze lidar data for different applications. Graduate standing required.

Credit Hour(s): 0 OR 3
Lecture Hour(s): 0 OR 2
Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture
Prerequisite(s): GEOG 5034, FOR 5254, FOR 5264
Corequisite(s):

GEOG 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):
Corequisite(s):

GEOG 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

GEOSPATIAL AND ENVIRONMENTAL ANALYSIS

Professors: James Campbell; Laurence Carstensen; Steven Hodges; Stephen Prisley; Randolph Wynne;

Associate Professors: John Galbraith; Conrad Heatwole; Marcella Kelly; Lisa Kennedy; Korine Kolivras; Kevin McGuire; Lynn Resler; Valerie Thomas; Carl Zipper;

Assistant Professors: Timothy Baird; Zachary Easton; Luke Juran; Robert Oliver; Yang Shao; Meredith Steele;

Research Faculty: William Ford;

General Contact: geospatial@vt.edu

Graduate Site: <http://geography.vt.edu/GEA/index.html>

Student Handbook: <http://geography.vt.edu/GEA/index.html>

The interdisciplinary doctoral program in Geospatial and Environmental Analysis focuses on the application of geospatial analysis for improving the science, management, and conservation of natural resources and the environment. Based in the College of Natural Resources and Environment, the program draws upon the expertise of faculty from the Departments of Forest Resources and Environmental Conservation, Geography, Fisheries and Wildlife Sciences, and Wood Science and Forest Products, as well as from those in departments in other colleges, including Crop and Soil Environmental Sciences, Civil and Environmental Engineering, and Biological Systems Engineering.

Geospatial research involves Geographic Information Systems (GIS), the Global Positioning System (GPS), remote sensing, and imagery analysis. Environmental analysis focuses on the complex interactions among people, nonhuman biota, and environmental conditions. This doctoral program combines cutting-edge training and research in the theory and application of geospatial science with environmental analysis to enhance research on a broad range of contemporary natural resource and environmental issues. Graduates will be prepared for careers in higher education, government, research, and industry.

SPECIAL FACILITIES

The program has a wide range of facilities necessary for advanced training in geospatial and environmental analysis, including state-of-the-art labs for GIS and for biogeography (for the study of recent and long-term environmental history and vegetation change). The Center for Environmental Applications of Remote Sensing (CEARS), housed in the College of Natural Resources and Environment, is a world-class geospatial research facility established in 1997 as a NASA center of excellence in applications of remote sensing to regional and global integrated environmental assessments. With core faculty in both the Geography and Forest Resources and Environmental Conservation departments, it is Virginia Tech's focal point for interdisciplinary research, instruction, and outreach focused on remote sensing applications. Doctoral candidates in this program will have the opportunity to interact with CEARS researchers who have extensive expertise with a wide variety of data types (including active and passive microwave, multispectral, hyperspectral, lidar, aerial photographs) and application areas (such as temperate and tropical forestry, limnology, ecological modeling, marine biology, environmental monitoring, urban ecology, carbon sequestration, tropical biodiversity assessment, phenology studies, rangeland management, invasive species, and fire fuel loading).

Facilities, Equipment, and Other Resources

Facilities, Equipment, and Other Resources Principal resources and facilities available to GEA students include those in student departments and within the College's Center for Environmental Applications of Remote Sensing (CEARS). Below are those within the Department of Geography and CEARS. PI workstation Operating System: Windows XP Hardware: Dell Optiplex 755 Processors: 3.2 GHz Intel Core Quatro Processor Internal Storage: 3.0TB Performance RAID (4 x 750GB SATA) External Storage: 2.0TB, 4 external 500GB hard drives Additional Student workstations Operating System: Windows Server XP Hardware: Dell Optiplex 745 Minitower Processors: 2.13GHz Intel Core Duo Processor Internal Storage: 200Gb Department Application Server Operation System: Windows Server 2003 Hardware: Dell PowerEdge 2600 Processors: Intel Xeon 2.8Ghz. Internal Storage: 1.8TB internal RAID 5 system External Storage: 21TB = 2 x 10.5 TB external RAID 5 systems Relevant Software's: ArcGIS-ArcInfo complete suite, Erdas IMAGINE 2010, ENVI & IDL 4.8, IDRISI Andes, Trimble Pathfinder, GPS correction extension for ArcGIS, GPS Analyst, Visual Studio 2020, SAS JMP, SURFER, GPS Utilities (for the Garmin GPS units) Geography Department Lab: Operating System: Windows 7 Hardware: 18 Dell Optiplex 990 Processor: INTEL I5, 3.6 GHz Ram: 8 GB per system Internal Storage: 500 GB Relevant Software's: ArcGIS-ArcInfo complete

suite, Erdas IMAGINE 2010, ENVI & IDL 4.8, IDRISI Andes, Trimble Pathfinder, GPS correct extension for ArcGIS, GPS Analyst, Visual Studio 2010, SAS JMP, SURFER, GPS Utilities (for the Garmin units) VT Department Graduate Student Workstations: Operating System: Windows XP Hardware: 6 x Dell Optiplex 745 Processor: Pentium 4, 3.40 GHz Ram: 4 GB per system Relevant Software's: IDL 4.0 versions, ArcGIS, ERDAS Imagine 2010, eCognition 5.0, GIMPimage editing. Storage: 200GB Department Network Type: TCPIP Internet Connectivity to EROS: 100 mbps GPS equipment available: 4 Trimble GeoXT 10 Trimble Juno (differential correction is supported) 10 Garmin Etrex Meteorological Equipment: 3 ea Campbell Scientific mobile metrological units: RM Young wind monitor, CSL Temperature/RH probe, Sentra 278 Barometer, Garmin GPS receiver, CR800-ST-SWNC Measurement & Control Datalogger Additional Departmental Resources Type: Large format Scanner Make: VIDAR Designer 18e Ijet Operating System: Windows XP Professional Hardware: Dell Optiplex 745 Processor: 2.8 GHz

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Students must complete 90 credit hours and a dissertation that involves original research. The program has three areas of required coursework totaling 31 credits. The first is composed of required Core Courses consisting of 13 hours of classes that provide training in advanced research techniques, statistical and spatial analysis, and discussion of contemporary issues in GIS and remote sensing. The second area of coursework requires the selection of 12 hours of electives in geospatial classes involving both GIS and remote sensing. The third area involves 6 hours of classes from electives in environmental analysis. Students must also complete a minimum of 30 hours of Research and Dissertation and 29 hours of other coursework and/or additional hours of Research and Dissertation. Students can transfer approved graduate coursework taken at Virginia Tech prior to enrolling in this program and up to 15 hours of coursework from another university.

NATURAL RESOURCES

Michael Mortimer, Program Director

Professors: Robert Hull; Patricia Raun;

Associate Professors: Marc Stern;

Adjunct Professors: Jerry Abrams; Mark Belleville; William Burns; Brian Czech; Desiree DiMauro; Megan Draheim; James Egenrieder; Heather Eves; Laura Giese; Jennifer Jones; Adam Kalkstein; Jennifer Lawrence; Daniel Marcucci; Joseph Maroon; Andrew Perlstein; Michael Ruggiero; Emily Talley; Louise Wise; Dequn Zhou;

Affiliated Faculty: Courtney Kimmel; Kieran Lindsey; Michael Mortimer; David Robertson;

Professor of Practice: Shelley Mastran;

MNR Info: mnrinfo@vt.edu

XMNR: <http://web1.cnre.vt.edu/xmnr/>

GMNR: <http://cligs.vt.edu/graduate-degrees/gmnr/>

Online MNR: <http://cligs.vt.edu/graduate-degrees/mnr/>

GCNR: <http://cligs.vt.edu/education/certificates/gradcert-nr/>

GCGS: <http://cligs.vt.edu/education/certificates/gradcertgs/>

The Vision Our vision for the Northern Virginia Natural Resources Program is to be a leader in the areas of natural resource policy, sustainable development of urban environments, and the sustainable management of natural resources in a global context. **Program Description** The expertise of the College of Natural Resources and Environment is not duplicated by any other university with a presence in Northern Virginia. While traditional natural resource education, research, and outreach programs have addressed issues involving rural environments, our program additionally addresses natural resource issues in the urban environment, the growing urban/rural interface, and international resource management in a global setting. Topics such as urban fisheries and wildlife management, urban forestry, open space management, green infrastructure, land use policy, water allocation, biodiversity conservation, and international sustainable development are among those emphasized. The non-thesis Master of Natural Resources (MNR) degree is offered from Falls Church and can be obtained in both classroom and virtual settings. The degree accommodates the needs of working professionals, and can be obtained part-time or full-time. A cohort-based executive version of the MNR degree (XMNR) focusing on leadership for sustainability, the first of its kind in the nation, is also available and a new cohort starts each January. A 12 credit Certificate of Graduate Studies in Natural Resources is also available. Finally, study abroad programs are offered each year for students looking to gain professional overseas work experience.

SPECIAL FACILITIES

Classes are offered at the Northern Virginia Centers in Falls Church, and more than 3/4 of the classes in each semester are also offered virtually.

DEGREES OFFERED

MNR Degree

Offered In (National Capital Region, Virtual)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

MNR must take 33 credit hours, including 4 core courses (12 credit hours); and prepare a capstone project (3-6 credit hours). XMNR is cohort-based with enrolled students taking the same courses simultaneously for 4 semesters. Total course credits are 30, with an additional capstone project for 3 credits. Certificate of Graduate Study in Natural Resources requires 4 courses (12 credit hours) and must include NR 5724 (Conservation Ecology).

GRADUATE COURSES (NR)

NR 5004:

Graduate Seminar in Natural Resources

Advanced exploration of special topics in natural resources through guest speakers, student/faculty presentations, small group projects, and critical reviews of pertinent literatures. Topics and format vary depending on interests of faculty and graduate students. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5014:

Constructing Sustainability

Synthesize ecological, economic, and solid dimensions of sustainable and resilient systems. Examine history, theory, current status, and future prospects of sustainability and resiliency as organizing principles for natural resource management professions. Situate science, policy, professional and civic institutions in sustainability efforts. Analysis sustainable and resilient bio-cultural systems. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5044:

Environmental Conservation and the American Landscape

Comprehensive examination of American attitudes toward the environment and the history of efforts to protect it, from early European settlers to conservationists of today. History of the U.S. Forest Service and the National Park Service, as well as other federal and private land

and resource conservation entities. Concept of wilderness, particularly within national parks and forests. Definitions of the American environment in the context of national development and our evolving strategies of environmental conservation. Primarily taught at National Capital Region. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5114:

Global Issues in Natural Resources

Study of the global economic and environmental consequences of the use of renewable natural resources. Emphasis on the world's forest, fisheries, and wildlife resources and on sustainable management. Seeks to enhance knowledge and understanding of the world's natural resources and the management of related industries from a global perspective.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5194:

Environmental Ethics

In depth analysis of current and past environmental issues in context of ethical and philosophical considerations starting from individual and group ethics and moving toward global and societal ethics. Addresses the interaction between influences and pressures such as social justice, cultural traditions, politics, science, technology, and religion and environmental ethics. Explores practical application of professional ethics to the resource decision-making process regarding current environmental issues. Graduate standing required, and National Capital Region students only.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5224:

Field Biology and Ecology

Field study of wild flora and fauna in natural habitats with special emphasis on composition, structure, function and processes of ecosystems in the Mid-Atlantic States. Methods and techniques used in field biology. Demonstration and application of field methods. Graduate standing required. National Capital Region students only.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5234:

Landscape Ecology

Landscape interactions between spatial patterns and ecological processes. Concepts, theories, and methodologies that illustrate spatial pattern importance for understanding landscapes interactions. Focuses on spatial relationships among landscape elements; flows of energy, mineral nutrients, and species among the elements; and ecological dynamics of the landscape mosaic through time. Explores landscape ecology from natural to urbanizing landscapes at scales associated with urban issues. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5344:

Natural Resources Law and Policy

In-depth examination of natural resource management laws and policies. Operation of laws, historical, and philosophical underpinnings. Emphasis on laws specific to wildlife, public lands, international policies, and scientific aspects of natural resource policy. All sources of law, including treaties, statutes, regulations, Executive Orders, and case law will be utilized, with a strong emphasis on U.S. federal law. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5364:

Private Lands Conservation Policy

Past and current public policy and program development on private farm and forestlands are studied in light of the issues influencing their evolution, management, and administration. Historical lessons and ecological concepts are applied to analysis of current policies and programs. Primarily taught at the National Capital Region. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5374:

Endangered Species Policy and Management

Holistic assessment of endangered species policy and management in the United States, focusing on the Endangered Species Act of 1973 as amended. Topics covered will include legislative history, policy design principles, and various technical issues, especially species prioritization and agency implantation. This course will also address the socioeconomic context of endangerment, including the politics of species conservation, ESA and democracy, ESA in the courts, and ecological economics of species conservation. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5384:

Wetland Ecology and Policy

Examination of the relationship of hydrology, soils, and vegetation to wetland ecosystem processes and the value of wetland functions. Evaluate wetland definitions and classification. Explore decisions toward protecting, restoring, impacting and mitigating wetlands. Assess federal, state and local regulations for wetlands. Graduate stading required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5414:

Urban Forest Management and Policy

Planning, designing, developing, managing, and maintaining trees and

associated natural resources in urban and suburban environments.

Ecological, socio-cultural, economic, and political components of urban forestry management and policy. Primarily taught at National Capitol Region. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5424:

Urban Wildlife

Provides a topical and historical overview of the field of urban wildlife and issues encompassed by wildlife in cities and towns. Focus will be on the structure and nature of cities as ecosystems. The role of wildlife within urban ecosystems and the relationships of people to wild animals will be explored. Graduate standing required. National Capital Region students only.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5614G:

Advanced Watershed Assessment, Management, and Policy

Multidisciplinary perspectives of assessment, management, and policy issues for protecting and improving watersheds 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: Graduate standing.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5634:

Urban Ecology

Theory and practice of urban ecology. The science and policy of urban ecosystems. Local, regional, and global aspects of urban ecological

processes. Social, historical, and political dimensions of urban ecosystem management and environmental governance. Strategies for sustainable urban development. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5644:

Interdisciplinary Recreation Planning

Outdoor recreation planning at community, state and federal land management unit scales. Explores strategies for integrating outdoor recreation in public land planning processes, accommodating other land use demands and disciplines within the planning area. Emphasizes contemporary, comprehensive, recreation planning tools. Introduces participatory leadership in a comprehensive, interdisciplinary, planning process. Defines roles and theories of interdisciplinary team leader and team player. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5654:

Outdoor Recreation Design and Development

Design and development of facilities for interpreting outdoor recreation to public lands users in locations from wilderness to urban areas. Focus on team approaches to comprehensive design and development from initial project identification, planning, interpretation and development through project design, construction, operations, and maintenance. Primarily taught at National Capital Region. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5674:

Public Lands and Realty Principles

Organization, legislative structure, and legal policy for managing public land real estate. Principles for land status records, boundary maintenance, withdrawal processing and title claim settlements. Focuses

on legal concepts, critical analysis, problem solving, and original thinking, including interactions with land management agencies and with professional organizations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): NR 5684

Corequisite(s):

NR 5684:

Foundations of Federal Land Management

Provides the framework for public land laws and policies development. Reviews the origins and status of significant laws and policies affecting federal land management, including the evolution to present and impacts. Emphasis is placed on legal concepts, critical analysis, and problem solving. Includes student interactions with land management agencies and with professional organizations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5714:

Ecosystem Management

Problem-based learning format to explore the application of ecological, economic, social, and management principles to natural resource management. Examines the changes in social values, technologies and demographics driving the ecosystem management model. Contrasts how the major federal agencies and other organizations implement ecosystem management. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5724:

Conservation Ecology

Explores the interdisciplinary knowledge, theories, and research related to natural resource management and conservation. Emphasis will be on the synthesis and integration of knowledge, skills and abilities required to develop innovative approaches to sustain resource development as

conservation issues become more complex. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5834:

Ecological Economics

Fusion of ecology and economics to assess the sustainability of economic policies. The economic system as an evolutionary function of the physical and biological environment. Effects of human economies on the environment and natural resources. Economic growth theory and policy in relation to sustainability of human society and management of natural resources. Distribution of wealth and allocation of resources. Primarily taught at National Capital Region. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (BIOL 2804 (UG) OR BIOL 2804), (FOR 3424 (UG) OR FOR 3424)

Corequisite(s):

NR 5854:

Natural Resources Communication Applications

Analysis of current communication theories and strategies used to address natural resource issues, how to evaluate these strategies, and elements necessary for successful communication programs. Students apply communication theories and models to a variety of complex natural resource issues. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5864:

Sustainability Science

Roles and limits of natural resources and the environment in relation to human, political, social, and economic goals and aspirations. Holistic and systemic focus on core questions of sustainability science including: examining interactions between human and natural systems; evaluating emerging models and conceptualizations of Earth-society sustainability; assessing impacts of long-term trends in nature-society interactions;

determining limits of resilience and sources of vulnerability for such interactive systems; developing incentive structures for guiding society toward more sustainable trajectories for interacting with the Earth; and harnessing science and technology to address sustainability goals.

Graduate standing required. National Capital Region students only.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5884:

Topics in Natural Resources

Advanced exploration of topical studies related to natural resources science, policy, and management. Topics and formats will vary, and course may be taken for credit more than once up to a total of 6 credits.

Graduate standing required. National Capital Region students only.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

NR 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5964:

Field Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

NR 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

NR 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lab, Lecture, Online Lecture

Instruction Type(s): Lab, Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NR 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

NR 6104:

Advanced Topics in Remote Sensing

In-depth coverage of advanced topics in the field of remote sensing selected to cover emerging techniques and technologies. Examples of topics, which will differ each semester, include field data in support of

remote sensing, accuracy assessment, and hyperspectral remote sensing. Critical assessment of the ways in which remotely sensed data and information are employed in varied scientific disciplines and by society.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): GEOG 4354 OR GEOS 4354, FOR 5254, GEOG 5104 OR FOR 5104

Corequisite(s):

NR 6314:

Advanced Topics in GIT

Literature, case study, and hands-on coverage of advanced topics in the fields comprising geographic information technology: geographic information systems, remote sensing, and the Global Positioning System, selected to cover emerging techniques and technologies, those too specialized to form components of the regular curriculum. Includes discussion of GIT tools as they fit into the domain of Natural Resources and general scientific inquiry. Application topics differ each semester. May be repeated. Recommended prerequisites: GEOG/GEOS 4354

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (GEOG 4084 OR GEOS 4084), (GEOG 5104 OR FOR 5104), GEOG 5314

Corequisite(s):

**ALLIANCE FOR SOCIAL, POLITICAL, ETHICAL,
AND CULTURAL THOUGHT**

Francois Debrix, Program Director

Professors: Francois Debrix;

Associate Professors: Bettina Koch; Chad Lavin; Rachel Scott; Brett Shadle;

Assistant Professors: Danna Agmon; Rohan Kalyan; Michael Moehler; Madhavi Murty; Patricia Nickel;

Affiliated Faculty: Ananda Abeysekara; Onwubiko Agozino; Aaron Ansell; Clair Apodaca; Mark Barrow; Brian Britt; David Brunisma; David Cline; Nicholas Copeland; Priya Dixit; Edward Ewing; Elizabeth Fine; Jessica Folkart; Matthew Gabriele; James Garrison; Laura Gillman; Heather Gumbert; Bernice Hausman; Matthew Heaton; Karen Hult; Sharon Johnson; Kathleen Jones; Jason Kelly; James Klagge; Ann Laberge; Christine Labuski; Robert Leonard; Marc Lucht; Ilija Luciak; Timothy Luke; Elizabeth Mazzolini; Marian Mollin; Wayne Moore; Amy

Nelson; Scott Nelson; Zhange Ni; Philip Olson; Lydia Patton; Joseph Pitt; Luke Plotica; Paulo Polanah; Katrina Powell; Karl Precoda; Anita Puckett; Karen Roberto; Patrick Roberts; John Ryan; Michael Saffle; Emily Satterwhite; Benjamin Sax; Andrew Scerri; Peter Schmitthenner; Helen Schneider; Paula Seniors; Amy Shuster; Robert Siegle; Barbara Smith; Robert Stephens; Max Stephenson; Ioannis Stivachtis; Gresilda Tilley-Lubbs; Gerard Toal; Peter Wallenstein; Ronda Watson; Edward Weisband; Laura Zanotti; Zac Zimmer;

General Contact: aspect@vt.edu

Student Handbook: <http://www.aspect.vt.edu>

The Ph.D. in Social, Political, Ethical and Cultural Thought (ASPECT) prepares graduate students to undertake theory-based, problem-centered, and interdisciplinary analysis informed by social, political, ethical and cultural thought. ASPECT is designed to interest those seeking a program of study with a framework wider than that of a specialized traditional disciplinary department. The program is unique in offering a curriculum that fosters research and teaching that communicates theory across the limits that frequently divide between units in the social sciences, humanities, and professional schools. The program promises to place in tandem bodies of thought and their research applications that have frequently cast divisions along fault line of political theory vs. cultural studies, social theory vs. ethical thought, etc. It is the modest ambition of the ASPECT curriculum, by contrast, to foster a research and teaching program that enables Ph.D. students to pursue appropriate course work and research commensurate with the complexities of the issues they aim to investigate. The curriculum stresses flexibility and originality. It permits a focus on overarching questions by offering training in areas of concentration as well as education in interdisciplinary ways of knowing. Each area of concentration, in turn, is composed of a cluster of multidisciplinary offerings. Students will be prepared to teach introductory and required courses in particular disciplines through their graduate teaching assistantships. However, their Ph.D. research will address questions that span a number of different approaches and fields in a truly interdisciplinary manner. The ASPECT Ph.D. curriculum is supported both by some seventy faculty affiliates (see: www.aspect.vt.edu) with tenure homes in twelve campus departments and three colleges: the College of Architecture and Urban Studies, the College of Business and the College of Liberal Arts and Human Sciences, including the four core departments of History, Philosophy, Political Science, and Religion and Culture.

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

The ASPECT doctoral program at Virginia Tech is for students who have previously earned an M.A. or equivalent (e.g. JD, MBA, MS) before pursuing doctoral study. Under the assumption that students accepted into the ASPECT program with a Masters degree or equivalent either from Virginia Tech or elsewhere have received credit for 30 credit hours, they then will undertake a minimum of 60 semester hours of further study, leading to the defense of a Ph.D. The Ph.D. curriculum concentrates on interdisciplinary methodological and theoretical issues. Therefore, ASPECT is where social, political, ethical, and cultural thought are put to work in understanding social and individual transformations in contemporary and historical contexts. Course requirements for the Ph.D. can ordinarily be completed during two years of residency and entail successful completion of 42 credit hours, leading to the defense of a Ph.D. dissertation proposal and preliminary exams during the fourth semester. Thereafter, dissertation research will be undertaken under the supervision of a multidisciplinary advisory committee and remaining credits may be earned either by taking additional classroom courses or research and dissertation credits. Students pursuing the ASPECT Ph.D. select a major and a minor concentration chosen from among four areas: 1) social thought, 2) political thought, 3) ethical thought, and 4) cultural thought. Additional ASPECT courses requirements offer education in interdisciplinary theory, methodology, and professional development. The ASPECT curriculum consists of four kinds of classroom courses: 1) All candidates will take 12 credit hours of core ASPT courses (ASPT 6004, ASPT 6104, ASPT 6204, and ASPT 6904); 2) 21 credit hours selected from ASPECT cross listed departmental offerings (six of the latter are brand new courses expressly designed to support program goals), 3) six credit hours in social science or humanistic research methods; and, 4) three credit hours in pedagogical practices (GRAD 5114). All students are required to identify a major and minor field (one each selected from the four concentration areas). The 21 credit hours mentioned in (2), are selected to fulfill the major and the minor areas of concentration, with 12 credit hours in the major and 9 credit hours in the minor area. No more than 9 credit hours can be taken in one department in fulfillment of the major area, no more than 6 from one department in the minor area.

GRADUATE COURSES (ASPT)

ASPT 5124:

Rel and Modernity in the West

A study of the relationship between religion and modernity in the West, with analysis of whether modern society is "disenchanted" or "secularized," or whether religion has remained a potent force in western society and thought. Through a survey of some of the major thinkers and themes of modern religious thought, we will consider the philosophical, economic, political, and legal aspects of the location of religion in the modern world. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ASPT 5134:**Islamic Political Thought**

The course will review the most significant elements of Islamic political thought throughout Islamic history: the teaching of the Qur'an, the formation of political thought in the medieval period, and the main trends of political thought in the modern world, including in the West. It will examine the connection between Islamic political thought in the medieval and modern periods. Graduate standing requires.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 5214 (HIST 5214):**Topics in Global History**

A variable content course exploring historiographical approaches to the study of global history from the classical age to the present. Special emphasis on chronological frameworks, histories and theories of globalization, and implications of new scholarship in global history for research and teaching. May be taken with different content for a total of 6 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 5244:**Constitutionalism in Theory and Practice**

The course investigates theories and practices of constitutionalism, both within the United States and more generally. It frames a number of questions about what characterizes constitutionalism as a distinctive theory of politics, while also examining the constitution, maintenance, change, and destruction in practice of constitutional orders, constitutions, constitutional institutions, and other constitutional norms. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 5414:**Topics in Cultural History and Theory**

A variable content course exploring the intersection of cultural theory and the discipline of history. Introduces important theoretical contributions to the study of culture and examines how historians have used these constructs to interpret the past. May be taken with different content for a total of 6 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 5464:**Critical Security Studies**

Provides an overview of the critical study of security in world politics. Introduces alternative conceptualizations of security to the military-focused, state-centric security/strategic studies. Considers constructivist, post-structuralist and critical theoretic attempts to conceptualize the nature of security. Compares and contrasts these approaches with widely-accepted understandings of security in light of key debates in contemporary security studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSCI 5444 OR PSCI 5444 (UG)

Corequisite(s):

ASPT 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ASPT 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ASPT 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

ASPT 6004:**Topics Interdisciplinary Perspectives in Soc, Pol, Ethical, & Cultural Thgt**

Topical seminar devoted to a significant problem in social, political, ethical and cultural thought. Integrates readings reflective of those four domains and is taught by an interdisciplinary team with research expertise in the particular problem addressed by the course. Via their substantive focus and advanced theory orientation, the seminar topics also offer comparative exposure to the ontologies and epistemologies embedded in disciplinary frameworks. Linked to a speaker series integrated with the course. May be repeated for a maximum of 9 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ASPT 6014:**Theories of Globalization**

Examination of past and present eras of globalization through various theoretical perspectives. Addresses colonialism and emergence of western models for development of poor countries. Controversies about impacts of current globalization on the nation-state, cultures, ecosystems, and racial/ethnic/gender inequalities. Explores present trends, such as globalization of agriculture and food systems, industrial production, migration, human rights, and anti-globalization resistance.

Pre-requisite may be substituted for any equivalent 5000 level international course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5264 OR UAP 5264

Corequisite(s):

ASPT 6024 (REL 6024):**Contemporary Religious Thought**

Concentrates on a selected major figure in religious thought in relation to contemporary society, politics, ethics, and culture. May be repeated up to five times with different content. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 6104:**Interdisciplinary Perspectives in Methodology**

Addresses problems of methodology that face researchers pursuing theoretically informed interdisciplinary research involving words, objects, and images. Provides exposure to disciplinary based and interdisciplinary methodologies. Emphasis on the methodological complexities of working in tandem with varied objects of analysis in theoretical and practical terms. Graduate standing and prior completion of an approved disciplinary based methodology course required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ASPT 6124:**Pre-Mod Chr & Isl Pol Theory**

Analysis of pre-modern Christian and Islamic political thought approached as comparative political theory. Integrates different genres (administrative handbooks, ethical writings, and philosophical treatises) from various Christian and Islamic cultural and religious settings. Pre-requisite: Prior completion of at least one 5000 level course in political theory, philosophy or an equivalent course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 6204:**Topics of Indisciplinary Frameworks in Soc, Pol, Cultural & Ethical Thgt**

181 Topical seminar devoted to a significant problem in social, political,

ethical and cultural thought. Integrates readings reflective of at least two of the four bodies of thought and theory addressed by ASPECT. Offers problem-centered, advanced exposure to interdisciplinary work. Team taught by two instructors with research expertise in the particular topic. May be repeated for a maximum of 9 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ASPT 6004

Corequisite(s):

ASPT 6224 (PHIL 6224):

Distributive Justice

Influential contemporary theories of distributive justice. Social, political, ethical, and cultural dimensions of distributive questions. Utilitarianism, liberalism, libertarianism, pluralism, multiculturalism, autonomy, rights, needs, (global) egalitarianism, and (global) poverty. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 6904:

ASPECT Professional Development

Preparation for successful completion of the interdisciplinary Ph.D. and for post-doctoral professional roles. Assists Ph.D. students in proposal preparation, identifying funding ASPECT related research, determining publication outlets and manuscript preparation requirements, and conference paper guidelines and presentation. Graduate standing in ASPECT doctoral program required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ASPT 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ASPT 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

COMMUNICATION

Robert Denton, Head

Emeriti Faculty: Edward Sewell;

Professors: Robert Denton; William Hopkins; John Tedesco;

Associate Professors: Rachel Holloway; James Ivory; Jim Kuypers; Jennifer Mackay; Marlene Preston; Beth Waggenspack;

Assistant Professors: Douglas Cannon; Michael Horning; Adrienne Ivory; Nneka Logan; Marcus Myers; Brandi Watkins;

W. Thomas Rice Chair: Robert Denton;

Graduate Contact: comm@vt.edu

Department of Communication: <http://www.comm.vt.edu/>

The M.A. in Communication prepares graduates to pursue communication doctoral studies, research positions in communication industries, and advanced teaching or professional careers. This thesis program blends social-scientific and humanistic research and communication theory in public and corporate advocacy, media effects, and media issues. The two-year, 33 credit hour thesis program introduces a diverse number of theoretical and methodological perspectives, with a focus on research in every class. Faculty strengths center on the impact of messages, media, and artifacts in social, political, organizational, and cultural contexts. Students engage in reviewing and discussing communication research and criticism, collecting and interpreting original research data, and synthesizing and presenting communication knowledge to educate others. They complete their degree with a thesis researching an area/question of interest in depth, using either a qualitative or a quantitative methodology. For Fall admission and consideration for graduate funding, the electronic application must be completed by January 15. First round decisions are made early in February. Second-round applications (excluding GTA funding requests) are accepted until April 15. Master's students present their research at regional and national conferences, and their scholarship appears in a range of publications. The program boasts a 100% placement rate at top Ph.D. departments for graduates interested in pursuing doctoral study. Communication M.A. students are active researchers, provide university and community service through the

Communication Graduate Students Association (CGSA), and establish a Hokie community of friends and colleagues.

SPECIAL FACILITIES

The Department of Communication has a research lab with several experimental and observation rooms. Research equipment contained in the labs includes the Biopac MP35 system with peripherals to measure skin conductance (EDA), electrocardiogram (ECG), facial electromyogram (EMG), electroencephalogram (EEG), noninvasive blood pressure, and push-button reaction time tasks. The research facilities also house Perception Analyzer real-time-response equipment, multiple large plasma-screen monitors, multiple video game console systems (e.g., PS2, Xbox360, Nintendo Wii, PS3), multiple presentation systems, networked laptop computer system, and two dedicated internal wireless servers. Graduate students may also benefit from our media production equipment.

Communication research facility

The Department of Communication has a research lab with several experimental and observation rooms. The VT G.A.M.E.R. Lab is a small laboratory facility dedicated to investigating the social impact of video games, immersive virtual environments, simulations, and related media technologies. Additional research equipment includes the Biopac MP35 system with peripherals to measure skin conductance (EDA), electrocardiogram (ECG), facial electromyogram (EMG), electroencephalogram (EEG), noninvasive blood pressure, and push-button reaction time tasks. The research facilities also house Perception Analyzer real-time-response equipment, multiple large plasma-screen monitors, multiple video game console systems (e.g., PS2, Xbox360, Nintendo Wii, PS3), multiple presentation systems, networked laptop computer system, and two dedicated internal wireless servers.

DEGREES OFFERED

MA Degree

Offered In (Blacksburg)

TOEFL

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal, Quantitative, Analytical

All graduate students receiving the M.A. degree in Communication must complete 33 credit hours. Required coursework includes 9 hours of core subjects (Communication Theory, Communication Research Methods, and Rhetorical Theory & Criticism), 15 hours of additional Communication coursework, and at least 3 hours of electives. In addition, all students must complete the MA degree with thesis (6 hours). In addition, each graduate student must pass a final oral defense administered by the student's advisory committee as well as a public presentation of thesis findings.

GRADUATE COURSES (COMM)

COMM 5014:

Communication Theory

A broad survey of contemporary theories and processes of interpersonal, public, and mediated human communication. Pre:

Graduate standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): COMM 5024

COMM 5024:

Communication Research Methods

Advanced treatment of a variety of research related issues germane to the discipline of communication studies. Topics include the scientific method; elements of the research process; experimental, quasi-experimental, and non-experimental research designs; and legal and ethical issues in research. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): COMM 5014

COMM 5034:

Teaching Practicum

Training in teaching the basic communication course at the university level. Emphasis on the theory and practice of teaching public speaking, prepared related materials and class sessions, and responding to student assignments. Graduate standing requires. May be repeated for up to 3 hours.

Credit Hour(s): 1 TO 2

Lecture Hour(s): 1 TO 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5044:

Prospectus Practicum

Applied, advanced work in prospectus development.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): COMM 5024
Corequisite(s):

COMM 5414:

Mass Media Effects

Explores major areas of theoretical study of mass communication and the social impact of mediated messages.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5444:

New Communication Technology

Explores the social implications surrounding the design, production, use, and evaluation of communication technology. Emphasis is on how communication functions in the creation and use of technology, and how communication and other social factors may be influenced by technology.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5454:

Mass Media Theory

Survey of theory related to the production, content, form, consumption, effects, and social role of mass media. Graduate Standing required

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5464:

Media Literacy

Theories and practices related to critical analysis, critique and evaluation of contemporary media's role in shaping society. Graduate standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5474:

International Communication

Relationships between communication and international systems and practices. Political, economic, legal and socio-cultural communication elements and the globalization of culture. Graduate Standing required.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5514:

Public Relations Theory and Practice

Examines fundamental theory and research in public relations, including systems theory, symbolic interactionism, organizational theory, cognitive processing and persuasion; models of public relations practice; ethics.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5524:

Organizational Communication

Theory and application of communication in organizational settings. Graduate standing required

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

COMM 5534:

Crisis and Issue Management

Characteristics and uses of crisis and issue management as communicative resources for organizations. Contributions of public relations practice in the creation of systems of meaning, public policy, and distribution of symbolic and tangible resources. Graduate Standing

required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5544:

Mass Media and US Politics

This course explores the role of the mass media in contemporary American politics by examining the development of the media as sources of social and political influence in twentieth century America; how the mass media cover electoral and issue campaigns; the impact such coverage has had on candidates and their campaign strategies and on the behaviors of voters. Various perspectives on what the future may hold for American politics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5554:

Health Communication Campaigns

Theory, practice, and effects of health communication campaigns on human behavior, society, and public policy. Graduate standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5564:

Persuasion and Social Influence

Examines fundamental theory and research on persuasion and social influence. Emphasis on a broad-based perspective, encompassing the full scope of persuasion as it is found in everyday life. This course examines persuasion in a variety of contexts and settings, including advertising, small groups, and face-to-face encounters.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5614:

Rhetorical Theory and Criticism

Survey of theories of rhetoric. Focuses on the multiple conceptions of rhetoric through history and the critical methods emerging from rhetorical theory.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5634:

Social Movement Campaigns

Communication theories and methods of studying social movement campaigns. Rhetorical construction of social protest. Graduate standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5814:

Seminar in Communication Studies

Topical seminar examining various aspects of contemporary theory and research in interpersonal, public, and mediated human communication. Repeatable with different content for a maximum of six hours credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5894:

Final Examination

For non-thesis candidates who are required to register for their final examination and have completed their program of study. Not to be included in minimum 36 hours required for degree.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

185 Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5904:

Project and Report

For students pursuing a non-thesis degree. Projects may involve guided research/scholarship or an internship.

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

COMM 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

COMM 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

COMM 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CREATIVE WRITING

Joseph Eska, Chair

Professors: Frederick D'Aguiar; Edward Falco; Nikki Giovanni; Lucinda Roy;

Associate Professors: Robert Hicok; Jeffrey Mann; Erika Meitner;

Assistant Professors: James Vollmer;

Affiliated Faculty: Gyorgyi Voros;

University Distinguished Professor: Nikki Giovanni;

Alumni Distinguished Professor: Lucinda Roy;

Gloria D. Smith Professor of Africana Studies: Frederick D'Aguiar;

Graduate Contact: jeffmann@vt.edu

Graduate Contact: sallyw@vt.edu

Graduate Site: <http://www.graduate.english.vt.edu/MFA/index.html>

The goal of MFA in Creative Writing is to immerse graduate students in a culture of productive creativity by doing the following: providing them with an opportunity to work in apprenticeship fashion with writing faculty; helping them to acquire a keen sense of the evolving landscape and the challenges in the field of creative writing; empowering them to create a dynamic learning community of writers in the heart of Southwest Virginia; and enabling them to develop the requisite skills they need in order to publish full-length collections of poetry and fiction. The program will prepare students for teaching at the college-level.

SPECIAL FACILITIES

DEGREES OFFERED

MFA Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The MFA in Creative Writing is designed to be completed in three years. Students may specialize in Fiction or Poetry. A minimum of 48 hours is required for this terminal degree. A series of creative writing workshops, courses in form and theory, new media writing, composition pedagogy, and literature and theory electives are designed for students wishing to pursue careers as writers or writer/scholars at the college level. Students also have the opportunity to work as editors on *The Minnesota Review* and *The New River: a Journal of Digital Writing and Art*. A creative thesis and a final exam are required. The 48 hours required for the degree must be distributed as follows: Creative writing workshops: 15 hours; at least 9 hours must be in the designated specialty; students are encouraged to explore other genres in 6 hours of workshops. Form and theory courses: 6 hours. Composition: 8 hours. Research & Thesis (5994): 6 hours; a book-length creative thesis (a collection of poetry; a collection of short stories, or a novel) Graduate English courses: 13 hours; students may use an independent study in Editing a Digital Journal, or Editing a Literary Journal, to fulfill this requirement.

EDUCATION, CAREER AND TECHNICAL

EDUCATION

Offered In (Blacksburg)

William Price, Program Director

Emeriti Faculty: Daisy Cartwright; Konrad Eschenmann; Patrick O'Reilly;

Professors: H Sutphin;

Associate Professors: William Price;

Visiting Faculty: Joseph Mukuni;

Affiliated Faculty: Thomas Broyles; Rickie Rudd; Donna Westfall-Rudd;

General Contact: wprice@vt.edu

Graduate Site: <http://www.soe.vt.edu/cte/index.html>

The Career and Technical Education (CTE) program at Virginia Tech is one of the top CTE graduate programs in the United States. Currently the program is tied for 4th in the country as ranked by U.S. News and World Report, and it has been a top-10 selection for the past 15 years. The program is designed to prepare individuals for careers in Career and Technical Education and to enhance the professional development of current career and technical educators. The CTE program offers a Master of Science degree (M.S.), an Education Specialist degree (Ed.S.), and a doctoral degree (Ph.D. or Ed.D.). There are two concentrations in the M.S. degree program: teacher licensure and professional development for practicing educators. The teacher licensure concentration includes all the requirements for earning the master's degree and all the Virginia Department of Education requirements for earning a license to teach in one or more of the CTE program areas: Agricultural Education Business and Information Technology Education Family and Consumer Sciences Education Marketing Education The doctoral program is primarily for individuals wishing to pursue a CTE teacher education position at a college or university. The Ed.S. degree is appropriate for individuals who seek careers in CTE programs at the local or state level. In addition to the degree options, the Virginia Tech CTE program also provides online professional studies courses for provisionally licensed CTE teachers. Courses taken in this program can also be used toward earning the M.S. degree.

SPECIAL FACILITIES

DEGREES OFFERED

MSED Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The requirements for the different master's degree concentrations vary and also depend on the student's background and goals. Please see the CTE program web site and consult an advisor for specific information.

EdS Degree

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Ed.S. degree requires a minimum of 60 credits beyond the bachelor's degree. Please see the CTE program web site and consult an advisor for specific information.

EdD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Ed.D. degree requires a minimum of 90 credits beyond the bachelor's degree. Please see the CTE program web site and consult an advisor for specific information.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Ph.D. degree requires a minimum of 90 credits beyond the bachelor's degree. Please see the CTE program web site and consult an advisor for specific information.

GRADUATE COURSES (EDCT)

EDCT 5114:

C&I in CTE: Prof Perspectives

Designed to provide provisionally licensed teachers in career and technical education (CTE) with an overview of roles and relationships within the teaching profession. Develops their knowledge of factors and resources for program planning and liability and safety issues for teachers. This is the first course in a sequence of six, one-credit courses.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5124:

C&I in CTE: Basics of Curr

Designed to provide provisionally licensed teachers in career and technical education (CTE) with instruction in the basics of planning and developing curriculum including needs analysis, course and unit planning, and student assessment. This is course two in a sequence of six one-semester hour courses.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCT 5114 (UG) OR EDCT 5114

Corequisite(s):

EDCT 5134:

C&I in CTE: Instr Strategies

Designed to provide provisionally licensed teachers in career and technical education with instruction in developing and delivering curriculum. Further develops the teacher's ability to use a variety of teaching strategies to meet the diverse population of students. This is the third course in a sequence of six, one-credit courses. Must have prerequisite or permission of the instructor.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCT 5124 (UG) OR EDCT 5124

Corequisite(s):

EDCT 5144:

C&I in CTE: Adv Instr Strat

Designed to provide provisionally licensed teachers in career and technical education with advanced instruction in developing and delivering curriculum. Develops the teacher's ability to use technology in instruction and to supervise work-based programs. This is the fourth course in a sequence of six, one-semester credit courses. Must have prerequisite or 00000000 permission of the instructor.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCT 5134 (UG) OR EDCT 5134

Corequisite(s):

EDCT 5154:

C&I in CTE: Prof Dev-Prog Mgt

Designed to provide provisionally licensed teachers in career and technical education (CTE) with instruction in a variety of program management tools related to their own professional development, their student organizations, and their program administration. This is course five in a sequence of six one-semester hour courses.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCT 5144 (UG) OR EDCT 5144

Corequisite(s):

EDCT 5164:

C&I in CTE: Diverse Learners

Designed to provide provisionally licensed teachers in career and technical education (CTE) with an understanding of the importance of diversity in our society, schools, and the workforce. Categories and characteristics related to diversity and disabilities are discussed, and assignments develop skills in adapting curriculum and instruction to best meet student needs. This is the sixth course in a sequence of six, one-credit courses.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCT 5154 (UG) OR EDCT 5154

Corequisite(s):

EDCT 5274:

Internship in Business

While employed in a business occupation, the student completes an In-depth study of the firm's policies, practices, and procedures. Under the supervision of the employer and a Career and Technical Education professor, focuses on various aspects of the business. Pre-requisite:

Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5604:

Foundations of Career and Technical Education

Focus on the history and development of career and technical education

purposes of career and technical education under different philosophical orientations are compared. An overview of the organization and administration, the relationship of career and technical education to agencies both in and outside of education, and how economic conditions have impacted career and technical education are explored. Definition and development of a personal philosophy is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5614:

Curriculum Development in CTE

Provides prospective career and technical education teachers with research bases, resources, and available curricula for teaching content in their respective fields. Develops the ability to plan, manage, develop, and evaluate curricula. Pre-requisite: Graduate standing in the CTE degree program.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5624:

Managing CTE Program

Responsibilities of the career and technical education teacher regarding work-based program standards, student guidance, school and community relations, on-the-job training, youth organization sponsorship, work-based program coordination, and program management. Pre-requisite: Graduate Standing Required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5644:

Curriculum and Program Planning in Career and Technical Education

Concepts and principles involved in curriculum and planning of career and technical education programs. Learning experiences focus on school and community needs assessment, curriculum content

identification and selection, designing curricula, and assessing curriculum materials and processes. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5654:

Strategies for Teaching Career and Technical Education

Focus on identifying the major instructional methods that are appropriate in career and technical education and identifying and resolving problems that emerge from these methods that can have a negative impact on the overall effectiveness of the teacher. Various methods to evaluate the teacher's instructional effectiveness are addressed. Graduate standing or two years of teaching experience required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5684:

Education and Employment Preparation for Diverse Populations

Study of policy and practices for developing and implementing career and technical education and employment programs that meet the needs of diverse/special needs, those youth and adults with disabilities, disadvantaged, limited English proficient, ethnic minorities, incarcerated youths, and single/teen parents. Specific attention to federal and state legislation and trends; the education foundation, programs and practices, which prepares students for career and technical education and training; and employment practices and programs. I, II, III.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5694:

Career and Technical Education for Adults

Focus is on the role, rationale, and teaching strategies for those adult learners enrolled in Career and Technical Education programs. Advanced content drawing heavily from contemporary trends and issues on the adult learner as synthesized from current research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCT 4254 (UG) OR EDCT 4254

Corequisite(s):

EDCT 5704:

Post-secondary Occupational and Community Service Education

An analysis of post-secondary occupational and community service education. Emphasis will be placed upon delivery through community colleges and review of other delivery systems including proprietary, military, and private business and industry will be addressed. The course will include a review of local, state, and national policies relating to the mission, curriculum, clientele, governance, finance, and evaluation of occupational and technical and community service programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5714:

Education and Work in a Changing Society

This course explores the major social, economic, and political issues and trends expected to have continuing impacts on career and technical education and the workforce. The current status and philosophies of career and technical education are evaluated relative to these changes. Alternative directions for the future are identified and analyzed, with emphasis on proactive rather than reactive strategies for educators.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCT 5604 (UG) OR EDCT 5604

Corequisite(s):

EDCT 5734:

Transition Programming for Individuals with Disabilities

In-depth study of transition policy, programs, procedures and services for diverse populations. Focus of course is on the comprehensive transition process including preparation for employment, post-secondary education and training, independent living skills, skills in accessing community services, social skills, recreation and leisure skills. Effective educational programming, community services, transition planning, and collaboration between education and community services at the secondary level will be

emphasized. I, II, III

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5754:

Internship in Education

Student participation in a planned clinical experience under supervision of a university staff member in an appropriate work center. (Max 12C).

Consent required.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5764:

Externship in Education

Problem-solving clinics for experienced career and technical education practitioners who are engaged part-time in graduate study while continuing in positions of leadership. Involves systemic analysis of current educational problems and evaluation of educational practice. (Max 12C).

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5784:

Graduate Seminar in Education

Selected topics in career and technical education related to curriculum development, special education, administration, research, and evaluation. (Max 6C per course)

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5904:**Project and Report**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

EDCT 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

EDCT 5954:**Study Abroad**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 6604:**Administrative Leadership for Career and Technical Education**

Administrative structure of career and technical education at the local, state, and national levels, and in business and industry; leadership for administrative planning, facilities and support services management, personnel management, supervision of instruction, professional development, and assessment in career and technical education.

Alternate years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5964:**Field Study**

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 6614:**Evaluation in Career and Technical Education**

Study of the theory and application of evaluation to career and technical education. Major emphasis on the unique requirements of program, personnel and student evaluation as specified in Federal and State legislation and regulations. National and state evaluations of career and technical education are assessed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCT 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

EDCT 5984:**Special Study****EDCT 6664:**

In depth treatment of the nature of policy and the policy-making process as they pertain to the workforce and to education, especially to career and technical education. Included are significant aspects of policy development at local, state, and federal levels; examination of the basic questions that are answered by policy decisions; appropriate organizations for formulation of policy; an examination of current policy pertaining to career and technical education at state and federal levels; and procedures for establishing policy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCT 5604 (UG) OR EDCT 5604

Corequisite(s):

EDCT 6944:

Professional Seminar

Critical review, presentation, and discussion of current literature, research, and national reports in designated areas of education. (6C max. credit allowed toward program of study) Consent required.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 7754:

Internship in Education

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 7964:

Field Studies in Education

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCT 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

EDUCATION, COUNSELOR EDUCATION

Gerard Lawson, Program Director

Associate Professors: Nancy Bodenhorn; Pamela Brott; Gerard Lawson; Laura Welfare;

Assistant Professors: Laura Farmer;

Visiting Faculty: Hannah Bayne;

Graduate Contact: glawson@vt.edu

Graduate Site: <http://www.soe.vt.edu/counselored/>

The Virginia Tech Counselor Education program offers a master's program (M.A.) at the National Capital Region and at the Virginia Tech Roanoke Center and a doctoral program (Ph.D.) at the National Capital Region and at the main campus in Blacksburg. Applicants should apply to ONE program at ONE campus only. The Virginia Tech Counselor Education Master's program is a 60 credit hour program, which generally takes a full-time student two years to complete. The first summer and fall semesters of the program consists of classroom study, and beginning in the spring semester students are engaged in clinical study throughout the remainder of their program. Students who graduate with a master's degree in the school counseling track are qualified and endorsed by the faculty for licensure/certification as school counselors by the Virginia Department of Education. They may also accrue supervision hours toward licensure (LPC) by the Virginia Department of Health Professions while serving as a school counselor. Those who graduate with a master's degree in the clinical mental health counseling track have completed all the courses required for LPC licensure in Virginia, and are prepared to enter the licensure residency period. Graduates need to complete 4000 hours of supervised practice to be eligible for licensure in Virginia, and can include their internship hours toward this state requirement. The Virginia Tech Counselor Education Ph.D. program prepares students to function as counselor educators, clinical supervisors, or advanced clinicians, through coursework and practical training. Strong preference in admission is given to applicants with at least two years of post-

masters clinical experience. Doctoral students complete advanced practica or internships in Teaching, Clinical Supervision, and/or Clinical Practice. Doctoral students in the Virginia Tech program have access to the latest instructional technologies, work closely with the faculty, and often collaborate on research, publications, and conference presentations. Students who complete the Ph.D. program typically seek employment in a variety of mental health settings and higher education, as well as K-12 schools. If students have not completed their LPC requirements prior to admission, courses and clinical doctoral internships can support that process.

SPECIAL FACILITIES

DEGREES OFFERED

MA Degree

Offered In (National Capital Region, Roanoke)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The masters programs require a minimum of 60 credit hours and a comprehensive exam, and the doctoral degree requires a minimum of 100 hours (post-baccalaureate) and a dissertation. Degree programs are accredited by the Council for Accreditation of Counseling and Related Educational Programs (CACREP) and by the National Commission of Accreditation and Teacher Education (NCATE). They are also approved by the Virginia Department of Education for the preparation of school counselors.

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The masters programs require a minimum of 60 credit hours and a comprehensive exam, and the doctoral degree requires a minimum of 100 hours (post-baccalaureate) and a dissertation. Degree programs are accredited by the Council for Accreditation of Counseling and Related Educational Programs (CACREP) and by the National Commission of Accreditation and Teacher Education (NCATE). They are also approved by the Virginia Department of Education for the preparation of school counselors.

GRADUATE COURSES (EDCO)

EDCO 5204:

Orientation to Professional Counseling

Survey of the philosophy, scope, purposes, and methods employed in a

variety of counseling settings including agencies, private practice, higher education, and elementary/middle/secondary schools with emphasis on services offered and professional identity and ethical issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 5214:

Theories of Counseling & Consultation

Major theories used to understand and change behavior in a counseling setting. Emphasis is placed on the application of theoretical orientations to understanding and changing behavior of clients. Systematic integration of themes used in the counseling process, including consulting and coordination roles in school and community settings.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5204 (UG) OR EDCO 5204

Corequisite(s):

EDCO 5224:

Counseling Techniques

Systematic integration of techniques used in the counseling process. Course provides extensive practice, learning, integrating, and practicing skills characteristic of effective helping relationships. Extensive use is made of audio and video feedback in critiquing counseling interviews and techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5214 (UG) OR EDCO 5214

Corequisite(s):

EDCO 5234:

Group Counseling

Introduction to group counseling theory and practice. Emphasis on application of group counseling principles to practical settings. In a laboratory setting, students receive feedback about their personal behavior in a group and supervised practice in the design, implementation, and evaluation of a short term group counseling project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (EDCO 5214 (UG), EDCO 5224 (UG)) OR (EDCO 5214, EDCO 5224)

Corequisite(s):

EDCO 5244:

Counseling Diverse Populations

Examination and application of counseling strategies for special client populations including the exceptional; economically disadvantaged; culturally, racially and ethnically different; those with different life styles.

Emphasis on the range of human characteristics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5204 (UG) OR EDCO 5204

Corequisite(s):

EDCO 5254:

Career Development and Information Services

Evolution of how the relationships of work and leisure have evolved into the concept of Career Development. Brief review of the major theories of Career Development and their application to the collection, evaluation, and use of career information in a variety of counseling/student development settings.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCO 5204 (UG) OR EDCO 5204

Corequisite(s):

EDCO 5264:

Appraisal In Counseling

Various individual and group tests and informal approaches to better understanding of the individual in counseling. Case study methods examined in detail. Interpretation of test data and role of counselor in testing emphasized. Designed for masters level counselor preparation. 12 additional hours of suitable courses in education, psychology, or statistics required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5204 (UG), (EDRE 5404 (UG) OR EDCI 4604 (UG)) OR EDCO 5204, (EDRE 5404 OR EDCI 4604)

Corequisite(s):

EDCO 5284:

Practicum: Counselor Education

Supervised experience in the practice of counseling. Didactic instruction in advanced counseling techniques and methods coupled with practice with clients in a supervised setting. Extensive feedback on counseling practice in individual sessions and group seminar. Must have liability insurance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (EDCO 5204 (UG), EDCO 5214 (UG), EDCO 5224 (UG)) OR (EDCO 5204, EDCO 5214, EDCO 5224)

Corequisite(s):

EDCO 5354:

Counseling the Substance Abuser

Provides an overview of the strategies, goals, methodologies, programs and types of knowledge and skills necessary for effective identification and treatment of addictions. Examines the classifications of drugs and other process addictions; impact of addictions on clients and their family members; components of addiction and recovery; prevention, treatment and relapse prevention resources; and salient legal and ethical guidelines. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 5364:

School Counseling

Theory and practice of school counseling at the elementary, middle, and high school level, and introductory skills for those settings. Provides understanding of basic services performed by the school counselor; developmental characteristics of the age groups served; ethical, legal and societal issues that affect school counselors; special education terminology; techniques useful in school counseling; and sources of materials available for educational and career counseling at various school levels.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (EDCO 5204 (UG), EDCO 5214 (UG)) OR (EDCO 5204, EDCO 5214)

Corequisite(s):

EDCO 5374:

Community Counseling

Designed for counselors who are interested in understanding, learning, and/or working as a counseling professional in a community counseling setting. Familiarizes students with community counseling and prepares them with skills for that setting. Examines concepts of social intervention, implications for the counseling process, the role of the community counselor, prevention in community counseling and current controversies and issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (EDCO 5204 (UG), EDCO 5214 (UG)) OR (EDCO 5204, EDCO 5214)

Corequisite(s):

EDCO 5424 (HD 5424):

Life Span Development

Stages of individual development as they occur in the context of the family life course. Overview of current developmental theories. Impact of race, gender, and class on cultural views of developmental norms.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCO 5604:

Graduate Seminar in Education

Selected topics in administration, counseling, adult and continuing education, research and evaluation, and community college and other domains of higher education. Emphasis is on interactive discourses on topics not typically included in regularly scheduled courses. (Maximum 3C per course).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCO 5614:

Internship

Clinical experience (minimum 600 hours) under the supervision of a university staff member and a site supervisor in an appropriate field site: school (at least 300 hrs K-6 & at least 300 hrs 7-12), community agency, university counseling center, or other setting. Extensive feedback in individual sessions and group seminar. (12 hours minimum for program).

Must have liability insurance.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5284 (UG) OR EDCO 5284

Corequisite(s):

EDCO 5624:

Externship in Education

Special problem-solving clinics for experienced educational practitioners who are engaged part-time in graduate study while continuing in positions of leadership in education. Faculty work with groups of experienced administrators, student personnel workers, supervisors, or instructors in systematic analysis of current educational problems and evaluation of educational practice. Students judged on quality of their investigations, reports, and discussion. (Maximum 12C).

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

EDCO 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Corequisite(s):

EDCO 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

EDCO 6304:

Clinical Supervision

A didactic and clinical study of supervision. Training in the differential conceptual approaches and the different methodologies of supervision, as well as the application of the theory and skills to actual supervisory processes with supervisees. Trainees will supervise master's students and document their supervision skills for clinical review. Students will supervise a counselor or intern as a part of the course and document with videotape. Must have liability insurance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 6404:

Advanced Counseling Theories and Multicultural Implications

Theories of counseling are examined in the context of contemporary research and practice, with particular attention to diverse populations and cultural influences. Effectiveness of selected past and contemporary counseling theories and practice with different populations is evaluated.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (EDCO 5214 (UG), EDCO 5224 (UG)) OR (EDCO 5214, EDCO 5224)

Corequisite(s):

EDCO 6414:

Advanced Group Counseling

Design, delivery, and facilitation of group counseling content at an advanced level. Students supervise group counseling practices of graduate students taking the basic master's course. Students participate in an intensive interpersonal examination of personal behavior in a group

setting and derive implications for group facilitation from both the experiential and reading bases. Extensive coursework and experience in counseling required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5234 (UG) OR EDCO 5234

Corequisite(s):

EDCO 6454:

Advanced Study in Career Development and Counseling Appraisal

Models and methods of assessment, use of data, approaches to program evaluation, effectiveness of models and treatment strategies, and theories pertaining to the principles and practice of career development and counseling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCO 5254, EDCO 5264

Corequisite(s):

EDCO 6474:

Advanced Practicum

Provides advanced graduate students in counseling/student development with in-depth supervision and student personnel experiences in various field settings. Experiences accompanied by intense faculty supervision and evaluation. (Maximum 12C). 30 hours previous coursework in the field required.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 6484:

Legal and Ethical Issues in Counseling and Consultation

Principles and practices of legal and ethical issues in counseling and consultation as applied to school, community counseling, and/or private practice settings. Discusses the laws, the court system, and court cases that affect counseling and consultation, as well as the sources and parameters of ethical behaviors. Examines the objectives and practices of ethical codes of counseling and consultation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 6524:

Doctoral Internship

Provides advanced graduate students in Counselor Education with in-depth supervision and experiences in various field settings for a minimum of 600 clock hours. May include supervised experiences in a clinical setting, clinical supervision, and teaching. Includes most activities of a regularly employed professional in the setting. Experiences accompanied by intense faculty and on-site supervision and evaluation. (12 hours minimum required in program). Must have liability insurance and instructor consent.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 6534:

DSM Application in Counseling

Advanced study of the criteria of mental disorders and standard diagnostic and assessment procedures. Provides students with the extensive knowledge and skills necessary to differentiate abnormal from normal behavior in children and adults, with special emphasis upon the identification and assessment of the mental disorders included in the Diagnostic and Statistical Manual of Mental Disorders (DSM). Emphasis will be on the application of the DSM in counseling situations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCO 6914:

Problems in Education

Study of contemporary problems in various education settings such as administration, counseling, community college education, and adult and continuing education. (Maximum 3C per course).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 6924:

Professional Seminar

Critical review, presentation, and discussion of current data-based and issues-related literature, either published or presented at recent national meetings. Provides students an opportunity to amalgamate their prior course experiences to produce a draft dissertation prospectus.

(Maximum 6C credit allowed toward program of study).

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 7704:

Field Studies in Education

Advanced applied research and/or evaluation study in one or more educational institutions or agencies. The student is graded on the basis of the design of the study and ability to conduct the study and report the results. (maximum 12C).

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 7714:

Internship in Education

Planned program of advanced clinical practice in education through assignment under direct supervision of outstanding practitioner for periods of up to two semesters. (Maximum 24C).

Credit Hour(s): 1 TO 24

Lecture Hour(s): 1 TO 24

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCO 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

Leader: Amy Azano (azano@vt.edu, 304 War Memorial Hall, 540-231-8889) Web site: www.soe.vt.edu/englished/index.html History and Social Science Education Program Leader: David Hicks (hicks@vt.edu, 313 War Memorial Hall, 540-231-8332) Web site: <http://www.soe.vt.edu/socialstudiesed/> Integrative STEM Education Program Leader: John Wells (jgwells@vt.edu, 317 War Memorial Hall, 540-231-8471) Web site: <http://www.soe.vt.edu/istemed/index.html> Mathematics Education Program Leader, Secondary Licensure in Mathematics: Betti Kreye (bkreye@vt.edu, 300D War Memorial Hall, 540-231-8348) Program Leader, Mathematics Specialist: Jay Wilkins (wilkins@vt.edu, 300C War Memorial Hall, 540-231-8326) Web site: <http://www.mathed.soe.vt.edu/> Music Education Program Leader: Kelly Parkes (kparkes@vt.edu, 322B War Memorial Hall, 540-231-0765) Web site: <http://www.soe.vt.edu/musiced/index.php> Reading Specialist/Literacy Program Coordinator: Heidi Anne Mesmer (hamesmer@vt.edu, 318 War Memorial Hall, 540-231-8343) Web site: <http://www.soe.vt.edu/literacy/index.html> Science Education Program Leader: George Glasson (glassong@vt.edu, 203 War Memorial Hall, 540-231-8346) Web site: <http://www.soe.vt.edu/scied/> Special Education Program Leader: Thomas Williams (thwilli1@vt.edu, 314 War Memorial Hall, 540-231-8337) Web site: <http://www.soe.vt.edu/specialed/index.html> Technology Education Program Leader: John Wells (jgwells@vt.edu, 317 War Memorial Hall, 540-231-8471) Web site: <http://www.soe.vt.edu/istemed/index.html>

EDUCATION, CURRICULUM AND INSTRUCTION

Emeriti Faculty: Daisy Cartwright; Konrad Eschenmann; Patricia Kelly; Stephen King; David Moore; Patrick O'Reilly; Mark Sanders; Thomas Sherman; Judith Shrum; Richard Stratton; Josiah Tlou; Terry Wildman;

Professors: Bonnie Billingsley; John Burton; Katherine Cennamo; Peter Doolittle; James Garrison; George Glasson; Barbara Lockee; Susan Magliaro; H Sutphin; Jesse Wilkins;

Associate Professors: Mary Barksdale; Brenda Brand; Jennifer Brill; David Hicks; Bettibel Kreye; Heidi Mesmer; Kelly Parkes; William Price; Gresilda Tilley-Lubbs; John Wells; Thomas Williams;

Assistant Professors: Amy Azano; Jennifer Bondy; Takumi Sato; Catherine Ulrich; Joycelyn Wilson;

Visiting Faculty: Joseph Mukuni;

Affiliated Faculty: Liesl Baum Walker; Thomas Broyles; Charles Burnsed; Edward Ewing; John Moore; Rickie Rudd; James Washenberger;

General Contact: nanboden@vt.edu

School of Education: <http://www.soe.vt.edu/index.php>

The Curriculum and Instruction graduate degrees are offered by 14 programs included in two departmental units in the School of Education. Listed below is contact information for the two departmental units and all of the programs in each unit, followed by degree information for the programs that use the Curriculum and Instruction degrees. Information for the two programs that have separate degrees is provided elsewhere in the Graduate Catalog. Learning Sciences and Technologies Departmental Unit Department Unit Chair: Katherine Cennamo, (cennamo@vt.edu, 201 War Memorial Hall, 540-231-9122) Web site: [soe.vt.edu/lst/index.html](http://www.soe.vt.edu/lst/index.html) Educational Psychology Program Leader: Brett Jones (jones1@vt.edu, 319 War Memorial Hall, 540-231-1880) Web site: www.soe.vt.edu/edpsych/index.html Foundations of Education Program Leader: Jim Garrison (wesley@vt.edu, 400B War Memorial Hall, 540-231-8331) Web site: <http://www.soe.vt.edu/foundations/index.html> Instructional Design and Technology Program Leader: Jennifer Brill (jnbrill@vt.edu, 300 B War Memorial Hall, 540-231-8328) Web site: www.soe.vt.edu/idt/index.html Teaching and Learning Departmental Unit Departmental Unit Chair: Bonnie Billingsley (billingsley@vt.edu, 309 War Memorial Hall, 540-231-8335) www.soe.vt.edu/tandl/index.html Career and Technical Education Program Leader: Bill Price (wprice@vt.edu, 206 War Memorial Hall, 540-231-7390) Web site: www.soe.vt.edu/cte/index.html (See Career and Technical Education for degree information.) Elementary Education Program Leader: Mary Alice Barksdale (mbarksda@vt.edu, 307 War Memorial Hall, 540-231-3166) Web site: www.soe.vt.edu/elementaryed/index.html English as a Second Language Education Program Leader: Gresilda (Kris) Tilley-Lubbs (glubbs@vt.edu, 300E War Memorial Hall, 540-231-4658) Web site: <http://www.soe.vt.edu/esled/index.html> English Education Program

SPECIAL FACILITIES

DEGREES OFFERED

EdS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

There are M.A., Ed.S., Ed.D. and Ph.D. degrees offered in Curriculum and Instruction. The specific requirements vary among the programs that award these degrees. Please see information on each program included in the Additional Information section and refer to program web sites for specific requirements.

EdD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

There are M.A., Ed.S., Ed.D. and Ph.D. degrees offered in Curriculum and Instruction. The specific requirements vary among the programs that award these degrees. Please see information on each program included in the Additional Information section and refer to program web sites for

specific requirements.

MAEd Degree

Offered In (Virtual, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

There are M.A., Ed.S., Ed.D. and Ph.D. degrees offered in Curriculum and Instruction. The specific requirements vary among the programs that award these degrees. Please see information on each program included in the Additional Information section and refer to program web sites for specific requirements.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

There are M.A., Ed.S., Ed.D. and Ph.D. degrees offered in Curriculum and Instruction. The specific requirements vary among the programs that award these degrees. Please see information on each program included in the Additional Information section and refer to program web sites for specific requirements.

GRADUATE COURSES (EDCI)

EDCI 5104:

Schooling in American Society

A study of the people and forces that impact on American education, analyzing the social setting of schooling and the relationships among school, curriculum, clients, personnel, and culture.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

EDCI 5124 (MUS 5224):

Behavioral Aspects of Music

Behavioral foundations of music research examining the influence of music on the performer and the listener. Perception, reaction, moods, powers of discrimination, and musical acoustics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5134:

Gender and Education

Introduction to gender in the context of education. This course is intended to raise awareness of how gender is implicated in teaching and learning in K-12 schooling and higher education. School policy as it relates to gender equality and sex education. Theoretical frameworks for gender analysis in education. Pre-requisite: Graduate standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5154:

Psych Foundations for Teachers

Emphasises applying human learning and developmental theories to classroom settings including school learning theories, child and adolescent cognitive development, instructional strategies, classroom management, student motivation, and learning assessment strategies. Graduate Standing Required. Admission in a graduate teacher education program or instructor permission required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSYC 2004 (UG) OR HD 1004 (UG)

Corequisite(s):

EDCI 5174:

Informal Learning and Youth

Overview of learning theories and empirical research on the influence of home, community, and museums upon learning in K-12 schooling. Practical application through visits to museums and after school programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5104

EDCI 5204:**Elem Sch Curriculum**

This course is concerned with the development of the elementary school curriculum. It deals with the structure, characteristics, problems and practices of the elementary school curriculum, the children, the environment and the school setting. The course is also concerned with the process of curriculum improvement and its implementation in contemporary elementary schools.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5214:**Linguistic Theory and Instruction in Reading and Written Expression**

Studies the syntactic structure of questions and their function and application to selected questioning strategies in reading and writing; explores ideas for the development of a systematic approach to teaching writing in conjunction with reading; discusses the use of stylistic devices and grammars in a reading and writing program using basal readers and children's literature.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5004 (UG) OR EDCI 5004

Corequisite(s):

EDCI 5224:**Advanced Curriculum & Instruction in Elementary & Middle Sch Social Studies**

Emphasizes curriculum research and recent developments in trends and materials in elementary and middle school social studies instruction.

Exploration of alternative approaches in instructional strategies. (1-3H, 1-3C).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5234:**Advanced Curriculum and Instruction in Elem & Middle School****Mathematics**

Research and recent developments in elementary and middle school math curricula; study and analysis of recent trends and materials; and examination of alternative approaches in methodology. (1-3H, 1-3C).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5244:**Advanced Curriculum and Instruction in Elementary and Middle School Science**

Selected study and analysis of curriculum trends, methods and materials. Emphasis on recent developments and the practical implications of research in science education. (1-3H, 1-3C).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5264:**Comprehending Processes and Reading in the Content Areas**

Explores basic processes involved in comprehension: the role of concepts about text structure, task demands, and the role of the reader; includes teaching strategies for comprehending and using information in content area texts and in job related materials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

EDCI 5274:**Specific Lrning Disabilities: Concepts, Theories, Characteristics & Issues**

Detailed study of current concepts for identifying learning disabilities. Analysis of characteristics exhibited by individuals with specific learning disabilities and etiological theories. Examination of major field developments, current issues, and factors influencing programmatic change. Emphasis on current research findings.

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCI 5554

Corequisite(s):

EDCI 5284:

Teaching Students With Specific Learning Disabilities

Study of holistic instructional needs and specific requirements of individualized educational programs for learning disabled students. Analysis of instructional methods and materials used for individuals with learning disabilities. Examination of frequently displayed problems and strategies to accommodate varying disabilities in basic skills, content areas, and life skills. Analysis of effective procedures for program organization, instruction, evaluation, and communication.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCI 5274 (UG) OR EDCI 5274

Corequisite(s):

EDCI 5294:

Methods of Teaching Students with Emotional and Behavioral Disorders

This course examines educational approaches that teachers can use to support children and youth who display social, emotional, and behavioral disorders. Emphasis will be placed on educational planning and program options, supportive interventions, and environmental and task management strategies to promote social-emotional development and well-being within the school setting.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5554 (UG) OR (EDCI 3144 (UG), EDCI 4174 (UG)) OR (PSYC 4174 (UG)) OR EDCI 5554 OR (EDCI 3144, EDCI 4174) OR (PSYC 4174)

Corequisite(s):

EDCI 5304:

Assessment for K-12 Literacy Instruction

Examines theory and practice of assessment in literacy education. Explores the range of current paradigms, including those associated with assessment as measurement, as procedure, and as inquiry. Focuses on the reciprocal relationship between assessment and instruction in literacy practices. Explores a variety of assessment practices and their

appropriateness for use with a diverse student population.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5004 (UG) OR EDCI 5004

Corequisite(s):

EDCI 5324:

Language, Literacy, and Culture (K-12)

The course assists educators in furthering their understanding of the connection between language, and the role culture plays within literacy development. Emphasizes how educators within the school context (K-12) need to be aware of, and utilize, the cultural background knowledge and linguistic resources, community needs of diverse students, and the community groups in which they belong. Major emphasis is on issues of literacy development in regard to oral, written, and multi-mediated texts. Graduate standing is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5334:

Conducting Literacy Inquiry

Course content develops student skills in analysis of classroom research studies and development of a mind set for becoming a teacher researcher. Familiarizes students with classroom research methodologies that provide the practitioner with skills for conducting a teacher research project within school contexts. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5344:

Review of Literary Research

Examines the methods and knowledge developed through the major traditions in literacy research and the social and political forces through which these traditions have been shaped. Graduate standing is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5354:

Literacies and Technology

The course will assist educators in the study of computer based technologies and the technological proficiency of students (K-12) within literacy development. Designed to prepare educators with knowledge of existing programs, uses of communication systems, and the development of presentation, web-based and software programs for use in the classroom.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5404:

Practicum in Clinical Reading

Diagnosis and remediation of reading problems. Each student works with children (K-12) in a clinical setting. The student is responsible for collecting relevant data, designing an appropriate program, carefully monitoring, and communicating progress in formal and informal reporting.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (EDCI 5004 (UG), EDCI 5304) OR (EDCI 5004, EDCI 5304)

Corequisite(s):

EDCI 5414:

Theory and Practice for Early Literacy Instruction (PK-3)

Examines language development and early literacy teaching and learning. Explores a wide range of current theories and practices including phonics based and meaning based approaches to teaching. Attends to how curriculum, instruction, and assessment reflect differing agendas for literacy and schooling and different definitions of literacy. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5424:

Theory and Practice in Content Literacy Instruction (3-6)

Focuses on comprehension and literacy development in middle grades. It explores a wide range of paradigms of comprehension and attends to how curriculum, instruction, and assessment are conducted within each paradigm. Special attention is given to socio-cultural and critical perspectives within literacy pedagogy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5414 (UG)

Corequisite(s):

EDCI 5444:

Teaching Adolescent Readers

Examination of active reading processes, instructional strategies, and appropriate adolescent literature for teaching both the developmental and the remedial reader in secondary language arts. Admission in a graduate teacher education program or instructor permission required. Pre-requisite: Graduate standing admission into a teacher education program or instructor permission.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5454:

Teaching Composition

Investigation of theory and research into pedagogy in teaching composition in K-12 settings. Consideration of the reasons K-12 students write, the ways they learn to write, and the genres and forms they utilize. Pre-requisite: Graduate standing, admission into a graduate teacher education program or instructor permission.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5464:

Advanced study of the physical, cognitive, social, and emotional development of the adolescent with emphasis on theoretical issues, research findings, and application of theory and research. Implications for education are highlighted.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5474:

Adapting Curriculum and Instruction for Students with Disabilities

Designing educational programs for students identified with disabilities, including informal assessment, curriculum modifications, instructional alternatives, and specialized materials and technology. Emphasis is on educational decision-making within a collaborative context involving educators, families, and specialists.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s): EDCI 3144, EDCI 5554

EDCI 5554:

Educating Exceptional Learners Across the Lifespan

Analysis of purpose, rationale, and foci of educational programs, and related services for individuals with special needs. Identification of characteristics associated with each exceptionality. Review of procedures for assessment, eligibility decisions, and the development of individualized educational programs. Overview of selected instructional strategies, environmental adaptations, and special materials.

Examination of findings concerning program efficacy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5555:

Reading Specialist Practicum

The practicum develops the skills necessary to enhance school-based learning communities focused on literacy development (K-12) by providing professional development opportunities for teachers and paraprofessionals. The first of the sequence of two courses details the

planning process of designing a literacy program within a school context that will identify and provide resources for teachers, administrators, and parents. The second course in the sequence provides the opportunity to implement and assess the literacy plan and to communicate the purposes of the literacy plan to policy makers and the community.

Graduate standing is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5556:

Reading Specialist Practicum

The practicum develops the skills necessary to enhance school-based learning communities focused on literacy development (K-12) by providing professional development opportunities for teachers and paraprofessionals. The first of the sequence of two courses details the planning process of designing a literacy program within a school context that will identify and provide resources for teachers, administrators, and parents. The second course in the sequence provides the opportunity to implement and assess the literacy plan and to communicate the purposes of the literacy plan to policy makers and the community.

Graduate standing is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5564:

Topics in Instructional Technology Tools & Methods

Introductory or advanced, project-oriented course which examines software tools used to create and organize data for a variety of media elements such as text, graphics, images, animation, audio and video. Topics also include principles, techniques, and modern practices used to produce and/or deliver interactive, multimedia applications for education, professional training, public information, and retail marketing. May be repeated to a maximum of 9 semester hours. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5654:**Supervision of Student Teachers**

A special training course for graduate students who supervise student teachers. Focus is on application of general supervisory principles to the student teaching experience. Training is provided in skills needed for the practice of a clinical approach to supervising student teachers. Special attention is given to protocols for serving in a liaison role for the university to the public schools and to alternative procedures for evaluating student teachers.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5674:**Assessing Individual Students' Educational Needs**

Examination of the purpose and process for individually assessing students' educational needs. Review of current assessment issues. Analysis of selected screening and diagnostic procedures available to regular and special education teachers. Experience in planning and conducting an individual educational assessment. Formulation of intervention strategies based on assessment findings.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDCI 4604 (UG), (EDCI 4554 (UG) OR EDCI 5554 (UG)) OR EDCI 4604, (EDCI 4554 OR EDCI 5554)

Corequisite(s):

EDCI 5684:**Crossing the Border Through Service-Learning**

Experiential education in the local Latino community through academic readings, community experience, journal reflections, and classroom discussions. Includes 50 hours per semester of interaction with Latino families in their homes, exchanging culture and language with recent immigrants to the New River and Roanoke Valleys. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5704:**Contemporary Issues in Music Education**

Selective study and analysis of historical and recent curriculum trends and materials; discussion and evaluation of research. Focus on socio-cultural, equity, philosophical, learner-centered, curriculum, assessment, technology, and critical pedagogical perspectives within K-12 music education. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5705:**Adv Curriculum & Instruction: Engl, for Lang, Math, Mus, Sci, Soc Studies**

The major issues and problems related to the teaching of English, foreign language, mathematics, music, science, or social studies; selective study and analysis of recent curriculum trends and materials; discussion and evaluation of research. Teaching experience required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5706:**Adv Curriculum & Instruction: Engl, for Lang, Math, Mus, Sci, Soc Studies**

The major issues and problems related to the teaching of English, foreign language, mathematics, music, science, or social studies; selective study and analysis of recent curriculum trends and materials; discussion and evaluation of research. Teaching experience required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5724:**Teaching in Middle and Secondary Schools I**

Introduces concepts and methods that enhance the teaching of specific academic disciplines (English, history and social sciences, science,

mathematics, foreign languages, and music) in combination with a field studies course. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5744:

Teaching in Middle and Secondary Schools II

Intensive instruction in methods of teaching an academic discipline (English, history and social science, science, mathematics, foreign languages, and music). Emphasis on classroom management, use of instructional technology, planning and delivery. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5754:

Internship in Education

Student participation in a planned clinical experience under supervision of a university staff member in an appropriate work center.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5764:

Externship in Education

Special interdisciplinary problem-solving clinics for experienced educational practitioners who are engaged part-time in graduate study while continuing in positions of leadership in education. Interdisciplinary teams of faculty work with small groups of experienced supervisors or instructors in systematic analysis of current educational problems and evaluation of educational practice. Students judged on quality of their investigations, individual reports, and discussion. (Maximum 12C).

Consent required.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5774:

Problems in Education

Study of problems of professional educators in such areas as supervision, instruction, and curriculum development.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5784:

Graduate Seminar in Education

Selected topics in curriculum and instruction, supervision, educational foundations, special education, research, and evaluation.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5804:

STEM Education Foundations

Provides an introduction to the nature of the science, technology, engineering, and mathematics (STEM) disciplines, and their corresponding STEM education disciplines; the inherent connections, confluences, and differences among the STEM and STEM education disciplines; the frameworks, standards, and infrastructures that govern the teaching of these subjects in K-16 STEM education; and other social, political, theoretical, and philosophical ideas and influences that underlie K-16 STEM education. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5814:

STEM Education Pedagogy

Provides an ordered investigation into the instructional practices and signature pedagogies of science, technology, engineering, and

integrative approaches for teaching/learning the content of these disciplines. Through study of the epistemologies, philosophies, strengths, and limitations associated with STEM signature pedagogies, students come to know a set of blended pedagogical practices that serve to enhance individual practices within their chosen fields. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5824:

STEM Education Trends & Issues

An exploration of contemporary K-16 Science, Technology, Engineering, and Mathematics (STEM) education trends and issues, including both integrative and within-discipline STEM education trends/issues. Topics addressed include STEM literacy, integrative approaches to STEM education, the changing role of design and inquiry in STEM education, STEM education-related legislation, change theory, state and federal funding, and extracurricular STEM education initiatives. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5834:

STEM Education Research

Designed as a structured investigation into the educational research methods and priorities among the science, technology, engineering, and mathematics (STEM) education disciplines. This course examines the various research methodologies used in studying teaching/learning issues within the context of STEM education disciplines. Students examine the similarities, distinctions, and overlaps among questions posed, research designs, and methods of studying best practices in order to better understand the teaching and learning processes among STEM education disciplines. Student gains in their understanding of these processes serve as the framework for preparing individual STEM-related action research proposals. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5844:

STEM Education Seminar

An open forum for the exploration of topics and issues reflective of the national educational reform efforts impacting the science, technology, engineering, and mathematics (STEM) disciplines, with particular attention to the broader context of concerns for developing a technologically literate populace within our educational system. Through a blend of readings, presentations, discussions, expeditions, and reflections on personal experiences, students develop an appreciation for STEM discipline perspectives relative to the educational process. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5854:

Biotechnology Literacy By Design

Addresses the field of biotechnology through technological design as a core curricular requirement reflective of the national Standards for Technological Literacy (STL) (ITEA, 2000). Using problem/project-based instruction, students develop a level of general science, technology, engineering, and mathematics (STEM) education literacy necessary for K-12 STEM educators to teach about biotechnology from a technological/engineering design approach. Students examine the content areas of biotechnology and apply the technological design method as they explore a variety of purposefully designed integrative instructional strategies for teaching at the intersections of the STEM disciplines. This project-oriented course provides students with the opportunity to apply instructional theories, principles, and practices in the design of authentic problem-based instructional units appropriate for inclusion into the K-12 STEM Education curriculum. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

EDCI 5964:

Field Studies in Education

Applied study in one or more educational institutions. Research, evaluation, curricular, and instructional projects are examples of appropriate projects of study. The student is graded on the basis of the design of the project and ability to carry it through and report the results.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

EDCI 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

EDCI 6014:

Advanced Topics in Teacher Education Curriculum

Intensive study of research findings and methods in preservice teacher education. Focus on internal and external issues that affect the curriculum, guidelines, accreditation, governance, alternative models, and approaches, instructional strategies, and history of teacher education reform. May be repeated to a maximum of 6 semester hours. Pre-requisite: Graduate Standing required.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5104

Corequisite(s):

EDCI 6024:

The Analysis of Educational Concepts

Systematic introduction to the study of contemporary philosophy of education, indicating ways in which philosophy is used to analyze educational aims, content, methods, and values.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5104

Corequisite(s):

EDCI 6034:

Education and Anthropology

Exploration of anthropological ideas and findings relevant to educational institutions and the teaching/learning process. Emphasis on how sociocultural patterns affect what is taught and learned.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

207 Prerequisite(s): EDCI 5104

Corequisite(s):

EDCI 6044:

Classroom Discourse

Overview of sociolinguistic theory to describe spoken language in the classroom. How discourse relates to learning as well as the establishment and maintenance of social relationships in schools.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5124 OR EDCI 5174

Corequisite(s):

EDCI 6054:

Acad Writing for Qual Ed Res

Writing workshop in which students work toward a personal goal (manuscript, book review, conference proposal, or fellowship application). Emphasis on how writing operates in the production, circulation, and elevation of knowledge in high education. Writing for qualitative research in education is the focus of this course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6504

Corequisite(s):

EDCI 6505:

Reading Research Seminar

Issues related to conducting and reporting research on the reading process and reading pedagogy. Includes the critical review of classical and contemporary research and an initiation to the process of conducting reading research. Special attention is given to the analysis and classification of major research paradigms.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (EDCI 5004 (UG), EDCI 5304 (UG)) OR (EDCI 5004, EDCI 5304)

Corequisite(s):

EDCI 6506:

Reading Research Seminar

Issues related to conducting and reporting research on the reading process and reading pedagogy. Includes the critical review of classical

and contemporary research and an initiation to the process of conducting reading research. Special attention is given to the analysis and classification of major research paradigms.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 6505 (UG) OR EDCI 6505

Corequisite(s):

EDCI 6534:

Ethnographic Methods in Educational Research

Exploration of ethnographic methods for data collection and analysis: theoretical bases, procedures, issues, and applications of this approach in educational research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 6034

Corequisite(s):

EDCI 6604:

Curriculum Theory and Organization

Examination of critical issues in curriculum including definition, theory construction, theories of human nature, structure of knowledge, school organization, and interaction with instruction. Analysis of alternative theories of curriculum in the context of the school, society, and broader theories of education.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDCI 5204 (UG) OR EDCI 5484 (UG) OR EDCI 5694 (UG) OR EDCI 5204 OR EDCI 5484 OR EDCI 5694

Corequisite(s):

EDCI 6644:

College Teaching

Teaching/learning process and consideration of teaching methods employed to encourage, guide, and evaluate college students' learning.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

208 Corequisite(s):

Corequisite(s):

EDCI 6944:

Professional Seminar

Presentation and critical discussion of current literature and major topics in curriculum and instruction. Provides students an opportunity to synthesize prior course experiences and to prepare and present a draft dissertation prospectus.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDCI 7754:

Internship in Education

Planned program of advanced clinical practice in education through assignment under direct supervision of an outstanding practitioner for periods of up to two semesters.

Credit Hour(s): 1 TO 24

Lecture Hour(s): 1 TO 24

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDCI 7964:

Field Studies in Education

Advanced applied study in one or more educational institutions. Research, evaluation, curricular, and instructional projects are examples of appropriate projects of study. The student is graded on the basis of the design of the study, ability to conduct the study, and interpret and report the results.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

EDCI 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

EDUCATION, EDUCATIONAL LEADERSHIP AND POLICY STUDIES

Emeriti Faculty: Don Creamer; Claire Curcio; Glen Earthman; Hilda Getz; Thomas Hohenschil; David Parks; Richard Salmon; Wayne Woner;

Professors: Michael Alexander; Penny Burge; Elizabeth Creamer; Joan Hirt; Carol Mullen; Kusum Singh;

Associate Professors: Nancy Bodenhorn; Pamela Brott; Carol Cash; William Glenn; Serge Hein; Steven Janosik; Michael Kelly; Gerard Lawson; Yasuo Miyazaki; Gary Skaggs; Laura Welfare;

Assistant Professors: Laura Farmer; John Gratto; Kami Patrizio; Ted Price; Claire Robbins; Valija Rose; Min Sun;

Visiting Faculty: Hannah Bayne;

Affiliated Faculty: Sharrika Adams; John Dooley; Martha Glass; Roderick Hall; Michael Herndon; Patricia Hyer; David Kniola; Patricia Perillo; Ellen Plummer; Donna Ratcliffe; Frank Shushok; Kimberly Smith; Kenneth Smith; Edward Spencer; Sherwood Wilson;

General Contact: nanboden@vt.edu

Leadership, Counseling, and Research: <http://www.soe.vt.edu/elps/index.html>

The Educational Leadership and Policy Studies department in the School of Education is chaired by Steve Janosik (sjanosik@vt.edu, 219 East Eggleston Hall, 540-231-5642). The web site for the department is: <http://www.soe.vt.edu/elps/index.html> The department includes four programs, listed here with the contact information for the program leader and the program web site: Counselor Education Program Leader: Gerard Lawson (glawson@vt.edu, 310 East Eggleston, 540-231-9703) Web site: <http://www.soe.vt.edu/counselored/> Educational Leadership Program Leader: Carol Cash (ccash48@vt.edu, Virginia Tech Richmond Center, 2810 Parham Road, Suite 300, Richmond, VA 23294) Web site: <http://www.soe.vt.edu/edad/Educational> Research and Evaluation Program Leader: Elizabeth Creamer (creamere@vt.edu, 211 East Eggleston, 540-231-8441) Web site: <http://www.soe.vt.edu/edre/index.html> Higher Education Program Leader: Steve Janosik (sjanosik@vt.edu, 219 East Eggleston Hall, 540-231-5642) Web site: <http://www.soe.vt.edu/highered/> The Educational Leadership and Policy Studies degrees are offered by the Educational

Leadership and Higher Education programs, and the following information relates to these programs. The Counselor Education and Educational Research and Evaluation programs have separate degree authorizations and are listed separately in the Graduate Catalog.

SPECIAL FACILITIES

DEGREES OFFERED

MA Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Higher Education Program offers the M.A.Ed degree only on the Blacksburg campus. The Educational Leadership Program offers the M.A.Ed. degree in Hampton Roads, National Capital Region, Richmond, Roanoke, and Southwest Virginia. Please see information on each program included in the Additional Information section and refer to program web sites for specific requirements.

PhD Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Higher Education Program offers the Ph.D. degree only on the Blacksburg campus. The Educational Leadership Program offers the Ph.D. degree only in Blacksburg. Please see information on each program included in the Additional Information section and refer to program web sites for specific requirements.

EdD Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Higher Education Program does not offer the Ed.D. degree. The Educational Leadership Program offers the Ed.D. degree in Hampton Roads, National Capital Region, Richmond, Roanoke, and Southwest Virginia. Please see information on each program included in the Additional Information section and refer to program web sites for specific

requirements.

EdS Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Educational Leadership Program offers the Ed.S. degree in Hampton Roads, National Capital Region, Richmond, Roanoke, and Southwest Virginia. Please see information on each program included in the Additional Information section and refer to program web sites for specific requirements.

EDUCATION, EDUCATIONAL RESEARCH, EVALUATION

Elizabeth Creamer, Program Director

Emeriti Faculty: Gabriella Belli;

Professors: Penny Burge; Elizabeth Creamer; Kusum Singh;

Associate Professors: Serge Hein; Yasuo Miyazaki; Gary Skaggs;

Assistant Professors: Min Sun;

General Contact: bev@exchange.vt.edu

Graduate Site: <http://www.soe.vt.edu/edre/>

The Educational Research and Evaluation (EDRE) program at Virginia Tech offers doctoral preparation in the areas of measurement, program evaluation, qualitative research methods, and statistics as they are applied in educational and other behavioral sciences. Graduates of the EDRE program are prepared for academic positions as research methodologists, positions in research and testing agencies, institutional research planning and assessment, or government positions as researchers, evaluators, or administrators of research programs in education or other areas of the behavioral sciences. The degree program is only available on the Blacksburg campus, but some courses may be taken at the Northern Virginia campus. Faculty members and students in the program conduct research relating to issues in education, assessment, and other behavioral sciences. Faculty in the program also provide research expertise to faculty members and graduate students in the School of Education by serving as methodology specialists on research projects and doctoral dissertation committees and by teaching courses in the areas of measurement, program evaluation, qualitative research methods, and statistics. Historically, the EDRE program was established in 1971 and was the first Ph.D. program in educational research in the State of Virginia. Over the years, the program has featured a small but high-quality group of students, granting 145 Ph.D.s to date (2010).

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

The Ph.D. program in EDRE requires a minimum of 90 hours of course work beyond the Bachelor's degree. These hours are divided among Research Methods, Electives, Masters/Cognate, and Dissertation Research requirements.

GRADUATE COURSES (EDRE)

EDRE 5404:

Foundations of Educational Research and Evaluation

Research and evaluation in education with emphasis on development of skill requisite for utilizing research and evaluation studies in practical situations. Applies these skills in exercises related to various research and evaluation models.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDRE 5604:

Graduate Seminar in Education

Selected topics in administration, counseling, adult and continuing education, research and evaluation, and community college and other domains of higher education. Emphasis is on interactive discourse on topics not typically included in regularly scheduled courses. (Maximum 3C per course).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

EDRE 5644:

Questionnaire Design and Survey Research in Education

This course provides an overview of survey research for graduate students in education. It covers the process from project formulation and sampling, through instrument design and question formulation, to data processing and report writing. Emphasis will be on questionnaire design, providing students with an opportunity to create and revise their own questionnaire and critique instruments used in educational surveys.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDRE 5404 (UG) OR EDRE 5404

Corequisite(s):

EDRE 5674:

Introduction to Mixed Methods

Introduction to Mixed Methods research and evaluation in applied social and behavioral sciences, including education, human development, sociology, and medicine. Mixed methods are used to collect and analyze both qualitative and quantitative data.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): EDRE 5404

Corequisite(s):

EDRE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

EDRE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

Qualitative Methods in Educational Research I

This course provides an introduction to qualitative research methods. It considers mainstream qualitative research traditions, including case study, phenomenology, ethnography, grounded theory, and participatory research. Students will conduct observations, interviews and basic data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 5404

Corequisite(s):

EDRE 6524:

Qualitative Methods in Educational Research II

This course provides an advanced examination of qualitative inquiry in educational and human science research. It considers theoretical assumptions of major qualitative research traditions and provides students advanced skills in data analysis and representation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6504

Corequisite(s):

EDRE 6604:

Behavioral Science Methods in Education

This course is designed to provide a broad survey of research methods used in the behavioral sciences with major attention devoted to qualitative, experimental, and survey type research. SPSSX will be used to reinforce and elaborate on statistical techniques taught in STAT 5634.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5634

Corequisite(s):

EDRE 6605:

Quantitative Research Methods in Education I & II

This two-course sequence is designed to provide an overview of basic research design, measurement and statistical concepts in social and behavioral research. Emphasis will be placed on understanding the process of social and educational research in field settings, hands on experience of designing and conducting research and analysis of data.

I,II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 5404 (UG) OR EDRE 5404

Corequisite(s):

EDRE 6606:

Quantitative Research Methods in Education I & II

This two-course sequence is designed to provide an overview of basic research design, measurement and statistical concepts in social and behavioral research. Emphasis will be placed on understanding the process of social and educational research in field settings, hands on experience of designing and conducting research and analysis of data.

I,II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 5404 (UG) OR EDRE 5404

Corequisite(s):

EDRE 6624:

Measurement Theory in Education

Methods and theories of estimating and enhancing test score characteristics, particularly reliability and validity of aptitude and achievement tests. Problems associated with test construction, use, and score interpretation will be emphasized.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5634

Corequisite(s):

EDRE 6634 (STAT 6634):

Advanced Statistics for Education

Multiple regression procedures for analyzing data as applied in educational settings, including curvilinear regressions, dummy variables, multicollinearity, and introduction to path analysis. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

EDRE 6644:**Advanced Research Design and Methodology**

Principles of experimental design with applications to the behavioral sciences emphasizing appropriate statistical analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5634 (UG) OR STAT 5634

Corequisite(s):

EDRE 6654:**Multivariate Statistics for Applications to Educational Problems**

Multivariate statistical procedures presented in an applied research setting. Oriented toward the logical extension of univariate tests of significance and estimation procedures to multivariate problems.

Emphasis on using existing computer software packages.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 6634 (UG), EDRE 6634 (UG), STAT 6644 (UG), EDRE 6644 (UG)) OR (STAT 6634, EDRE 6634, STAT 6644, EDRE 6644)

Corequisite(s):

EDRE 6664:**Application of Structural Equations in Education**

Applications of structural equation causal models in educational research and discussion of the methodological questions pertaining to such models. Topics include recursive and nonrecursive models, measurement errors in causal models, latent unobserved variables, and covariance structures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6634

Corequisite(s):

EDRE 6684:**Instrument Development and Validation**

Provides experiences in developing instruments, or tests, that are designed to measure educational and psychological constructs, such as knowledge, skills, attitudes, and traits. Issues and practices relating to construct specification, instrument design and administration, and analysis and summary of validity study data will be emphasized. Must

have EDRE 6606 prerequisite or comparable graduate level statistics course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6606

Corequisite(s):

EDRE 6694:**Hierarchical Linear Modeling**

Provides a conceptual framework of hierarchical linear modeling (HLM), some important statistical theory behind the HLM, and hands-on training for applying HLM technique through analyzing example data sets and projects. The course includes the formulation of statistical models for typical applications such as two-level organizational study, two-level growth model, and three-level growth model within contexts and prepares students to be able to use multilevel analysis to address research questions in their fields and write coherent summaries and interpretations of the results.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6634

Corequisite(s):

EDRE 6704:**Evaluation Methods in Education**

Principles of evaluation with emphasis on practices applicable to a variety of educational settings. The theoretical and philosophical bases which lead to alternative methodologies. Design and measurement alternatives are considered within the jurisdictional, theoretical, and philosophical contexts.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

EDRE 6744:**Mxd Method Research Dsgn**

Provides an introduction to mixed methods research design in the human and behavioral sciences. Students will design and execute a pilot study for a mixed method research project.

213 Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6606, EDRE 6504

Corequisite(s):

EDRE 6754:

Advanced Item Response Theory

Provides students with the concepts and skills to carry out Item Response Theory (IRT) analyses using specialized software, and an introduction to research in measurement. Topics will include binary and polytomous models, item and ability parameter estimation, model fit, and scaling and equating.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6624 OR EDRE 6684

Corequisite(s):

EDRE 6764:

Advanced Rasch Measurement

Provides theory and experiences in applying variants of the Rasch model. Theory and practices relating to the use of polytomous, mixture, and multidimensional Rasch models, as well as their application to common measurement problems such as differential item functioning, analysis of rater effects, and parameter estimation will be emphasized.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6684 OR EDRE 6624

Corequisite(s):

EDRE 6774:

Advanced Issues in Psychometric Research

Provides an in-depth look at one or more research topics in psychometrics, or the statistical foundations of educational and psychological tests. Students will become familiar with current research, acquire specialized psychometric analysis skills, and learn how to conduct psychometric research. Topics covered may vary from term to term. May be repeated for a maximum of 12 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6624, EDRE 6684

Corequisite(s):

EDRE 6784:

Advanced Issues in Qualitative Research

Provides advanced treatment of important theoretical and methodological topics in the contemporary qualitative literature and in the ongoing development of qualitative methodology. Emphasis is placed on addressing both theoretical issues and issues of research praxis. Topics covered vary from term to term.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6524

Corequisite(s):

EDRE 6794:

Advanced Topics in Educational Research

Advanced treatment beyond standard courses in topics such as questionnaire design, survey sampling, factor analysis, and meta analysis. May be repeated with different topics for up to 6 hours of credit.

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 5634

Corequisite(s):

EDRE 6914:

Problems in Education

Study of contemporary problems in various education settings such as administration, counseling, community college education, and adult and continuing education. (Maximum 3C per course).

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDRE 6924:

Professional Seminar

Critical review presentation, and discussion of current data-based and issues-related literature, either published or presented at recent national meetings. Provides students an opportunity to amalgamate their prior course experiences to produce a draft dissertation prospectus.

Credit Hour(s): 1 TO 6
Lecture Hour(s): 1 TO 6
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

EDRE 6944:

Professional Seminar

Critical review, presentation, and discussion of current data-based and issues-related literature, either published or presented at recent national meetings. Provides students an opportunity to amalgamate their prior course experiences to produce a draft dissertation prospectus. (Maximum 6C credit allowed toward program of study).

Credit Hour(s): 1 TO 6
Lecture Hour(s): 1 TO 6
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

EDRE 6974:

Independent Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

EDRE 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

EDRE 7714:

Internship in Education

Planned program of advanced clinical practice in education through assignment under direct supervision of outstanding practitioner for periods of up to two semesters. (Maximum 24C).

Credit Hour(s): 1 TO 24
Lecture Hour(s): 1 TO 24
Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDRE 7964:

Field Studies in Education

Advanced applied research and/or evaluation study in one or more educational institutions or agencies. The student is graded on the basis of the design of the study and ability to conduct the study and report the results. (Maximum 12C).

Credit Hour(s): 1 TO 12
Lecture Hour(s): 1 TO 12
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

EDRE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

ENGLISH

Joseph Eska, Chair

Professors: Frederick D'Aguiar; Joseph Eska; Edward Falco; Virginia Fowler; Thomas Gardner; Diana George; Nikki Giovanni; Peter Graham; Bernice Hausman; Nancy Metz; Timothy Parrish; David Radcliffe; Lucinda Roy; Robert Siegle; Paul Sorrentino;

Associate Professors: Kelly Belanger; Sheila Carter-Tod; Gena Chandler-Smith; Anthony Colaianne; James Dubinsky; Charlene Eska; Carlos Evia Puerto; Shelli Fowler; Paul Heilker; Robert Hicok; Shoshana Knapp; Jeffrey Mann; Erika Meitner; Katrina Powell; Karen Swenson;

Assistant Professors: Katie Carmichael; Katharine Cleland; Elizabeth Mazzolini; James Vollmer; Abby Walker; Quinn Warnick;

Affiliated Faculty: Mark Armstrong;

University Distinguished Professor: Nikki Giovanni;

Alumni Distinguished Professor: Thomas Gardner; Lucinda Roy;

NationsBank Clifford A. Cutchins III Professor: Paul Sorrentino;

Edward S. Diggs Professor in Humanities: Bernice Hausman;

Gloria D. Smith Professor of Africana Studies: Frederick D'Aguiar;

Graduate Contact: ceska@vt.edu

Graduate Contact: sallyw@vt.edu

Graduate Site: <http://www.english.vt.edu/graduate/MA/index.html>

The MA program at Virginia Tech is focused upon the theoretical and practical aspects of evaluating texts and analyzing language in all its aspects. Special attention is paid to the critique and production of digital discourse. Our graduates typically move in one of three directions upon completion of their degree: enrollment in a PhD program in literature or writing; high school- or instructor-level teaching; writing or document-related jobs in industry.

SPECIAL FACILITIES

Center for the Study of Rhetoric in Society:

<http://www.rhetoric.english.vt.edu/index.html> Linguistics Speech Lab

DEGREES OFFERED

MA Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal, Quantitative, Analytical

The degree requires 36 hours of coursework. All students must take two required courses in Literary Research (5014) and Critical Theory (5024). They must also complete a capstone project which has a thesis (6 credits) and a non-thesis (3 credits) option. Because work in literature and language frequently is interdisciplinary, students are permitted to take six of their credits outside of the department. Students with a Graduate Teaching Assistantship must also take the following pedagogically-oriented courses: ENGL 5004 Theory and Practice in University Writing Instruction (6 credits); GRAD 5004 GTA Training Workshop (1 credit); and GRAD 5124 Library Research Skills-English (1 credit). http://www.english.vt.edu/graduate/MA/policies_procedures.html

GRADUATE COURSES (ENGL)

ENGL 5004:

Theory & Pract Univ Writ Inst

The study of rhetorical theory, related issues in writing pedagogy, and the practice of teaching composition at the university level for GTAs in the Department of English. Pre-requisite: Graduate Standing and appointment as a GTA in the Department of English.

Credit Hour(s): 6

Lecture Hour(s): 4

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5014:

Introduction to Literary Research

This course introduces the materials and methods of research used in English studies. Students learn how to locate primary texts, contextual documents, and critical scholarship, to evaluate their kinds and degrees of authority, and to incorporate and cite this material in original research.

Pre: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5024:

Critical Theory in English Studies

Introduces graduate students to principal issues, concepts, terms, and methods currently employed in literary criticism and the interdisciplinary study of culture. Pre: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5034:

Practicum

Practical training in teaching composition at the university level. Required of all Graduate Teaching Assistants in English. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5054:

Composition Theory

Study of history and theory of teaching composition at the university-level. Introduction to research methods in Composition Studies. Detailed consideration of the epistemological and cultural implications of writing

216 instruction. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5064:

Topics in Language

Rotating topics in language study, exploring various theories of language and their bearing on literary interpretation, rhetoric, and textual criticism.

Content will vary; may be repeated once for credit. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5074:

Introduction to Digital Humanities

This course introduces students to the history and critical theory necessary to understand the broad import of digital technology for English Studies and to the knowledge and skills required to critique and produce digital documents. Must have graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5084:

Creative Writing Practicum

Training in teaching introductory creative writing at the university level.

Emphasis is on the theory and practice of teaching creative writing, preparing materials and class sessions, and responding to student writing. Pre-requisite: Graduate Standing in the MFA program in the Department of English and appointment as a GTA.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5094:

Collab Research Practicum

Practical training in collaborative research practices in discourse analysis, ethnography, historical investigation and other subjects at the graduate level. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5104:

Writing Proj Invitational Inst

Study of the theory, research, and practices of teaching, writing and educational leadership for participants selected for the National Writing Project. Introduction to research methods and overview of current research Composition. Study of collaborative learning theory and participation in an intensive writing workshop. Production of a substantial and varied portfolio of personal and professional texts. Pre-Requisite: Graduate Standing required.

Credit Hour(s): 6

Lecture Hour(s): 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5114:

Studies in Medieval Literature

Rotating studies in medieval literature, focusing on particular themes, genres, works, or figures within their historical, social and literary context. Content will vary; may be repeated for credit. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5124:

Studies in Renaissance Literature

Rotating studies in British literature from 1500 to 1660, focusing on literary traditions, themes, or representative writers. May be repeated once for credit. I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

217 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5134:

Studies in Eighteenth-century Literature

Rotating studies in English Literature of the eighteenth century, focusing on literary traditions, themes, or representative writers. Content will vary; may be repeated once for credit. I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5144:

Studies in Nineteenth-century English Literature

Rotating studies in English literature of the nineteenth century, focusing on literary traditions, genres, themes, or representative writers. Contents will vary; may be repeated once for credit. I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5154:

Studies in American Literature Before 1900

Rotating studies in American literature before 1900, focusing on literary traditions, themes, or representative writers. Content will vary; may be repeated once for credit. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5164:

Studies in Black American Literature

Rotating studies in Black American literature, focusing on its roots in folk and oral traditions; on key periods, such as the Harlem Renaissance; or on themes, genres, or selected figures. Content will vary; may be repeated once for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5174:

Studies in Twentieth-century Texts

Rotating studies in twentieth century literature in English. Typically, the course will concentrate on a kind of writing, a movement, a theme, or a critical issue. Content will vary; may be repeated once for credit. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5224:

Studies in Early English Authors

Rotating studies in the works of such early writers as Chaucer, Shakespeare, or Milton, focusing on their relationship to history; on key texts; on themes or genres; or on critical approaches. Content will vary; may be repeated once for credit. I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5234:

Studies in Later English Authors

Rotating studies in the works of one or two later English writers, such as Dickens, Hardy, Tennyson, Woolf, Joyce, Yeats, and others. Contents will vary; may be repeated once for credit. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5244:

Studies in American Authors

Rotating studies which offer intensive treatment of one or two American authors, with particular attention to historical, biographical, cultural,

and/or critical and theoretical contexts. Content will vary; may be repeated once for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5314:

Genre Studies

Rotating studies of particular genres--lyric, biography, literary criticism, speculative fiction--in relation to their social, intellectual, and literary contexts. Content will vary; may be repeated once for credit. I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5334:

Special Topics in Literature

Approaches to the study of literature that cross the boundaries of genre, period, and nationality, exploring innovative combinations of texts, critical methods, and interpretive approaches. Contents will vary; may be repeated once for credit. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5354:

Comparative Studies in Literature

Rotating studies in global literature and theory, focusing on comparisons of authors, works, periods, or genres of different regions, countries, and/or cultures. Content will vary; may be repeated once for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5454:

Studies in Theory

Rotating studies of the major issues, figures, and movements in literary and critical theory. Content will vary; may be repeated once for credit.

I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5514:

American Literature of the Later Nineteenth Century

American literature from the Civil War to the end of the century, with emphasis on Whitman, Dickinson, Twain, James, and Crane. I,II,III,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5534:

Studies in Literary History

Rotating studies in literary history. Topics, periods, and approaches will vary; may be repeated once for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5614:

Visual Rhetoric and Document Design

Examination of the theories, research, and practices of visual rhetoric and document design. Emphasis on ways in which images and other visual methods of communication influence audiences. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Intercultural Communication

Examination of theoretical and practical issues pertaining to writing and designing for intercultural and/or international audiences. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5634:

Writing and Publishing in Electronic Environments

Examination of the ongoing evolution of rhetoric and writing as a technology-supported field. Prepares graduate students to analyze and solve design problems related to rhetorical delivery and content management in digital and online contexts. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5644:

Genres of Professional Practice

Variable topics in genres of professional practice, such as reports, proposals, manuals, and websites; includes study of the genre in use as well as development of an example of the genre. May be repeated twice for credit when the topic varies for a total of nine credits. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s):

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5654:

Professional Writing Pedagogy

Theoretical and practical aspects of designing and teaching an introductory undergraduate course in technical or business communication in academic or business settings. Students will investigate various methods and materials used to teach written, oral, and visual communication appropriate for such courses. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5674:

Rhetoric of Science and Technology

Analysis of the historical and philosophical development of the field of rhetoric of science and technology through benchmark publications; examination of scientific texts and technologies as objects of rhetorical criticism. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5734:

Form and Theory of Fiction

A graduate course for writers of fiction in which students are taught to analyze the forms and theories which underlie the development of the genre. Students will be asked to critique the theoretical assumptions which have been applied to the genre and study the history and conventions that have shaped the writing of fiction. They will be required to interrogate the forms and prevailing theories which have shaped major novelists and short story writers, and apply what they discover to the crafting of their own fiction.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5744:

Form and Theory of Poetry

A graduate course for practicing poets and writers in which students are taught to analyze the forms and theories which underlie the development of the genre. Students will be asked to critique the theoretical assumptions which have been applied to the genre and study the history and conventions that have shaped the writing of poetry. Students will analyze prosody; imitate metrical forms, such as the sonnet and the sestina; and adapt the techniques used by poetic masters. Students will study the works of a wide array of writers, from Chaucer to contemporary

theories which have shaped the voices of poets through the ages.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5754:

Form and Theory of Drama

A graduate course for practicing playwrights and writers in which students are taught to analyze the forms and theories which underlie contemporary playwriting. Students will be asked to critique the theoretical assumptions which have been applied to the genre and study the history and conventions that have shaped playwriting and performance. Special emphasis will be placed on the interplay between theory and performance, and the influence of aesthetics on dramatic form and performance practices as students learn to adapt those approaches to their own playwriting.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5764:

New Media Creative Writing

A graduate course in creative writing in a digital environment, which provides the experienced creative writer with an opportunity to develop a hypertext project. Students will learn a variety of techniques appropriate for writing designed to be read in a digital environment and adapt them to their own texts. Primary focus is on the composition of an original hypertext, but students are also required to analyze the work of influential "new media" writers and critics of the hypertext genre.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5774:

Editing a Literary Journal

Introduction to the process of editing a literary journal. As editors for the MFA Program's online journal of poetry, fiction, and essays. Developing critical skills as the basis for editorial decisions. Understand the

dominant literary aesthetics informing contemporary writing; accept or reject submissions; maintain correspondence with authors; and meet deadlines. May be taken up to three times for a maximum of 9 credits. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5894:

Final Examination

For non-thesis candidates who are required to register for their final examination and have completed their program of study. Not to be included in minimum 33 hours required for degree. II,IV

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ENGL 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

221 Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGL 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENGL 6304:

Disciplinary Issues in Rhetoric and Writing

Examination of the research questions and methods, theories, body of knowledge, sites of practice, and forums of rhetoric, professional and technical writing, and composition. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6314:

Classical Rhetoric in Written Communication

Study of major figures and concepts in classical rhetoric, with emphasis on applications to written communication. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6334:

Rhetoric in Society

Study of the relationship of language and human action, with emphasis on how rhetoric reflects and shapes social practices and how literate activity operates in a complex society; emphasis on written communication. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6344:

Rhetoric in Digital Environments

Study of the uses of digital media in research, information development and sharing, and advocacy regarding public issues. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6364:

Research Design in Rhetoric and Writing

Theory and practice of evaluating, designing, and conducting empirical research projects in rhetoric and writing. Focus on critiquing studies, developing research questions, selecting methods, and designing projects. Introduction to appropriate statistical concepts and methods as well as qualitative and hybrid methodologies. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6374:

Field Methods of Research in Rhetoric and Writing

Examination of field methods and methodology in rhetoric and writing, including case studies, ethnographies, qualitative interviews, and field/participant observations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6514:

Studies in Rhetoric

Studies in the history, topics, sites of practice, and major figures of rhetoric, with application to written communication and English Studies. May be repeated twice for a total of 9 hours credit when the topic varies. Graduate standing required.

222 Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6524:

Theories of Written Communication

Studies in theories applied to written communication. May be repeated twice for credit for a total of 9 hours when the topic varies. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6554:

Composition Studies

Studies in the history, topics, sites of practice, and major figures of Composition. May be repeated twice for credit for a total of 9 hours when the topic varies. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6704:

Fiction Workshop

This advanced course in fiction writing provides those who wish to pursue careers in creative writing with the tools they need to develop as novelists and short story writers. Primary focus in on the writing and critiquing of original short stories and longer pieces of original fiction, while paying close attention to the work of established fiction writers who are acknowledged masters of their genres. This course may be repeated up to the maximum credit hours (15). Previous workshop experience is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6714:

Poetry Workshop

This advanced course in poetry writing provides those who wish to pursue careers in creative writing with the tools they need to develop as poets. 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. This course may be repeated up to the maximum credit hours (15). Previous workshop experience is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6724:

Playwriting Workshop

This advanced course in playwriting provides those who wish to pursue careers in creative writing with the tools they need to develop as playwrights. Primary focus is on the writing and critiquing of original plays, while paying close attention to the work of established dramatists who are acknowledged masters of their genres, and to the aspects of playwriting that relate to theatrical production. This course may be repeated up to the maximum credit hours (15). Previous workshop experience is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6734:

Creative Nonfiction Workshop

Advanced course in creative non-fiction writing providing those who wish to pursue careers in creative writing with the tools that they need to develop as essayists and memoirists. Primary focus is on the writing and critiquing of original creative nonfiction, while paying close attention to the work of established creative nonfiction writers who are acknowledged masters of their genres. Course may be taken up to six times for a maximum of 18 hours of credit. Previous workshop experience is required. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 6744:

New Media Writing Workshop

Advanced course in New Media writing that provides students with the knowledge and skills required to develop in this area of creative writing.

Primary focus is on the writing and critiquing of original New Media works. Course may be repeated for up to a total of 12 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGL 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FOREIGN LANGUAGES, CULTURES, AND LITERATURES

Jacqueline Bixler, Head

Professors: Jacqueline Bixler;

Associate Professors: Elisabeth Austin; Jessica Folkart; Aarnes Gudmestad; Medoune Gueye; Sharon Johnson; Corinne Noirot; Moses Panford; Richard Shryock; Fabrice Teulon; Ronda Watson;

Assistant Professors: Catalina Andrango-Walker; Maria Cana Jimenez; Alexander Dickow; Sarah Sierra; Vinodh Venkatesh; Zac Zimmer;

Alumni Distinguished Professor: Jacqueline Bixler;

Graduate Contact: MA.FLCL@vt.edu

Graduate Site: <http://www.fl.vt.edu/graduate>

The Master of Arts in Foreign Languages, Cultures & Literatures is designed to meet the needs of students seeking academic and other professional careers in contexts that require intercultural competency as well as a specialized knowledge of Spanish and/or French. The program serves the interests of students seeking an interdisciplinary approach to learning. Coursework includes areas such as literature, cultural studies,

cinema, art history, translation, linguistics and business. The core of the program provides a solid foundation in Hispanic, French, and Francophone cultures and literatures. It stresses the acquisition and development of analytical abilities based on a range of critical approaches. These skills prepare students to work independently in a variety of settings. The students may be beginning or experienced teachers of secondary-level Spanish and French, those planning to work in international environments, or those considering doctoral studies at other universities.

SPECIAL FACILITIES

The MA in French/Francophone, Hispanic, or Multilingual Studies may be completed at the Blacksburg campus, or online through the Virtual campus. The Blacksburg campus offers students the full services of the university, including an extensive library, technology support, and the Graduate Life Center. Online students are expected to attend classes in real time over the internet using a webcam and software available for download from the university. Most MA courses are offered in the late afternoon or evening (Eastern time).

DEGREES OFFERED

MA Degree

Offered In (Virtual, Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General: Verbal, Quantitative, Analytical

The program offers three tracks: French and Francophone Studies, Hispanic Studies, and Multilingual Studies. Within each track, students will take a combination of required core courses and electives. In addition to coursework, students must either write a thesis or take an examination based on a reading list. A committee of three faculty members will evaluate the thesis or the examination results. Procedures and requirements are outlined in the program's Policies and Procedures manual. It is expected that students enrolled full time will complete all degree requirements within two academic years. This normally includes devoting the summer to do research for the thesis or to prepare for the examination. For further details, see the program's policy manual, available at www.fl.vt.edu/ma.

HISTORY

Mark Barrow, Chair

Professors: Mark Barrow; Arthur Ekirch; Edward Ewing; Richard Hirsh; Peter Wallenstein;

Associate Professors: Glenn Bugh; Beverly Bunch-Lyons; Heather Gumbert; Matthew Heaton; Kathleen Jones; Marian Mollin; Amy Nelson; Paul Quigley; Helen Schneider; Brett Shadle; Neil Shumsky; Robert Stephens; Daniel Thorp;

Assistant Professors: Danna Agmon; David Cline; David Felt; Carmen Gitre;

Dennis Halpin; Dennis Hidalgo; Melanie Kiechle; Warren Milteer; LaDale Winling;

Adjunct Professors: Edward Gitre;

Robertson Professor of Civil War Studies: Paul Quigley;

General Contact: lifounta@vt.edu

Graduate Site: <http://www.history.vt.edu/graduate.htm>

The Master of Arts program in History provides talented students with advanced training in the professional practice of historical research and pedagogy. The program serves three primary constituencies: students preparing for further graduate work at the doctoral level, those who wish to become secondary school educators, and those planning for careers in a range of public history fields (the program offers a specialized Graduate Certificate in Public History). By preparing broadly-trained practitioners who have research expertise in a chosen field of specialization the MA in history also offers an excellent foundation for careers in public relations, journalism, law, and public service. Quite apart from its vocational promise, History is a foundational discipline in the humanities, and the serious study of the past is a source of intellectual enrichment and a lifelong endeavor. For more information about the graduate program please consult our website: <http://www.history.vt.edu/graduate.htm>

SPECIAL FACILITIES

DEGREES OFFERED

MA Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General Test: Verbal (158.0), Quantitative, Analytical (4.5)

The department offers a Master of Arts in History and a Master of Arts in History-Area Studies (an interdisciplinary program with the Department of Foreign Languages and Literatures). Both degrees require a minimum of 30 semester hours of credit. Because research and writing are fundamental tenets of the discipline of History, students are expected to complete a thesis as part of their plan of study. Students who choose the non-thesis option submit a research paper for approval to an advisory committee. For more information about policies and degree requirements see: http://www.history.vt.edu/graduate_students/standards_policies.htm

GRADUATE COURSES (HIST)

HIST 5024:

Area Studies Methods

Introduction to recent theories and methods in history, foreign languages

and literary studies, and geography with a focus on issues that have facilitated exchanges between the three disciplines. Practical aspects of Area Studies research are highlighted with particular reference to Latin America, the Caribbean, and Europe. The formulation of research problems using interdisciplinary approaches is given special attention. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5104:

Historical Methods

Introduction to the theoretical frameworks and historiographical debates that inform the contemporary research and writing of history. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5114:

U.S. to 1877

American history, from European discovery through Reconstruction. Emphasis on major themes and developments in the emergence of the United States: exploration and settlement; encounters among Europeans, Africans, and Native Americans; achievement of political independence; territorial expansion and political conflict; immigration, industrialization, and urbanization; Civil War, emancipation, and Reconstruction. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5124:

U.S. Since 1877

Introduction to main themes in U.S. history beginning with post-Civil War industrialization. An intensive readings course emphasizing the social, cultural, political, economic and military changes in the century after Reconstruction. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HIST 5134:

Research Methods for Historians

Introduction to skills and methods used in the research, writing and publication of historical scholarship.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): HIST 5104
Corequisite(s):

HIST 5144:

The Transatlantic World

Comparative and interdisciplinary study of encounters and exchanges between Europe, Africa, and the Americas. Surveys the literature on selected topics from the onset of European colonization until the present time.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HIST 5205 (STS 5205):

Main Themes in the History of Science and Technology

Methods and concepts in the history of science and technology. 5205: research methods, interpretive approaches, and contemporary issues in the history of science; 5206: research methods, interpretive approaches, and contemporary issues in the history of technology. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HIST 5206 (STS 5206):

Main Themes in the History of Science and Technology

Methods and concepts in the history of science and technology. 5205:

research methods, interpretive approaches, and contemporary issues in the history of science; 5206: research methods, interpretive approaches, and contemporary issues in the history of technology. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HIST 5214 (ASPT 5214):

Topics in Global History

A variable content course exploring historiographical approaches to the study of global history from the classical age to the present. Special emphasis on chronological frameworks, histories and theories of globalization, and implications of new scholarship in global history for research and teaching. May be taken with different content for a total of 6 credit hours. Graduate standing required.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HIST 5224:

Readings in African History

Variable topics readings course focusing on historiographical trends on particular themes in African history. May be taken with different content for a total of 6 credit hours. Pre: Graduate standing.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HIST 5254:

Topics in Modern European History

Advanced intensive research seminar in the development of European history since the Enlightenment. Variable content course. May be repeated with different topics for credit. II.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):

Corequisite(s):

HIST 5264:

Readings in Latin American History

Variable topics readings course in Latin American history focusing on intersecting themes such as race/class/gender and environment/technology/culture and emphasizing the most recent trends in the historiography. Students will be expected to write a literature review of recent secondary sources. Variable content course. May be repeated for a maximum of 6 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5274:

Topics in Latin American History

Variable topics research seminar in Latin American history. Emphasis will be placed on planning a research agenda and analyzing primary sources - visual, oral, and written- within the context of recent trends in the historiography. Students will be expected to write an original article length research paper based on primary sources. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5404:

Development of Modern American Science

Development of the sciences and the community of scientists in the American national context. Emphasis on scientific, institutional, and social events from 1830s through 1980s, including the circumstances surrounding the creation of nuclear weapons and the emergence of "big science." An interdisciplinary perspective, exploring traditional and contemporary historiographical and methodological issues and approaches. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5414:

Topics In Cultural History and Theory

A variable content course exploring the intersection of cultural theory and the discipline of history. Introduces important theoretical contributions to the study of culture and examines how historians have used these constructs to interpret the past. May be taken with different content for a total of 6 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5424:

Public History

Introduction to the theoretical, interpretive, controversial, and practical issues facing public historians. Focus on interpretations and specific issues surrounding the presentation of history in museum exhibits, documentary films, photographic collections, community history projects, the Internet, and a variety of other public venues. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5434:

Oral History Methods

Theory and methodology of oral history methods. Use of oral history interviews in historical research, questions of ethics, interpretation, and the construction of memory. Technical operations and a variety of interview techniques, transcription, and historical use of interviews. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5444:

Digital History Methods

227 Methods for researching and presenting history in a digital environment,

with special emphasis on use of digital media as a tool for public historians. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5454:

Topics in Public History

Current methodological issues facing public history professionals, the intellectual foundations of these issues, and changing standards of practice in the field of public history to engage students in practical, experiential projects in public history. May be taken for a maximum of 6 credit hours. Pre: Graduate standing.

Credit Hour(s): 3 TO 6

Lecture Hour(s): 3 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5484 (PSCI 5484) (GIA 5484):

Contemporary American Foreign Policy

Covers U.S. foreign policy during the Cold War, the stalemate with the Soviet Union, armament and arms control, containment and deterrence, detente and Reaganism, and the end of the Cold War. Briefly covers events from 1989 to the present. Designed for students with an interest in foreign policy and the global affairs. Prereqs or instructor's permission.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5214, PSCI 5444

Corequisite(s):

HIST 5504:

Modern European History

Major problems and interpretations of European history from the 18th century to the present. Comparative and theoretical approaches to understanding social movements and transformation, social class and ethnicity, and the politics of culture and "exceptional histories" such as Germany and Russia. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5534:

Imperialism, Nationalism, and Decolonization

Imperialism, nationalism and their legacies in the twentieth century. Concentration on imperialism and nationalism as categories of historical analysis. Critical examination of the imperial and colonial experiences and of the expansion and transformation of the nation-state system as a consequence of decolonization and global restructuring. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5544:

Understanding The Israeli Palestinian Conflict

Dynamics of the Israeli-Palestinian conflict. Critical issues that underlie the conflict and divide Israel and the Palestinians. Diplomatic efforts aimed at resolving the conflict. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HIST 5564:

African American Women in United States History

This course is designed to explore the historical, socio-cultural and political forces that have contributed to the development of an African American female experience in the United States. Taught chronologically beginning with the Colonial period, emphasis will be given to the evolution of significant themes, relying on race, class, gender, and regionalism as critical modes of analysis. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HIST 5614:

Development of America from 1607 to 1828. Emphasis upon social, economic, cultural, and political changes as well as different patterns of regional growth. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5624:

Jacksonian America and the Civil War

This graduate seminar focuses first on the social, economic, and political events which led to civil war, and then on various aspects of the war itself. Special emphasis also will be placed on the major political and military leaders of the period. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5644:

Modern Am Since 1920

The transformation of the United States from a powerful but isolated industrial nation with minimal military forces into its current role as industrial and military superpower. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5674:

Civil Rights Movement

This course will explore the modern U.S. Civil Rights Movement, 1930s - 1960s, a combination of litigation, direct action, and political efforts that sought to eliminate the various facets of Jim Crow, particularly segregation and disfranchisement, from the nation in general and the South in particular. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5684:

The U.S. South

A reading colloquium on the history of the south during various periods of its history. Emphasis upon the emergence of the south as a separate and distinct region and the basis of southern identity from the years of slavery to the present. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5694:

Amer Environ Hist

Examination of the important ways Americans have shaped and been shaped by the natural environment from the time of European contact with the New World to the present. Emphasis on the evolution of environmental concern in the nineteenth and twentieth centuries. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HIST 5914:**Race and Slavery in Comparative Perspective**

Race and slave societies in the modern world. Emphasis on major themes and developments since the seventeenth century. Comparative and theoretical approaches to understanding slavery in North and South America, the Caribbean, Russia, and South Africa. Concentration on similarities and differences in the slave trade, the origins of racial slavery, and the evolution of slavery as a system of racial oppression. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5934:**Gender in U.S. History**

Theoretical approaches to understanding the role of gender in political, economic and social life and in popular culture. Survey of major themes and developments since the seventeenth century. Concentration on the development of biological and sociological explanations of gender differences and similarities, and on the evolution of gendered politics and work and family relationships. Emphasis given to class, race, ethnic differences and differences in sexual orientation. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5964:**Field Work/Practicum**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

HIST 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HIST 6124:**Pre-Mod Chr & Isl Pol Theory**

Analysis of pre-modern Christian and Islamic political thought approached as comparative theory. Integrates different genres (administrative handbooks, ethical writings, and philosophical treatises) from various Christian and Islamic cultural and religious settings. Pre-Requisite: Prior completion of at least one 5000 level course in political theory, philosophy or an equivalent course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HIST 6224:**Science, Technology and the Enlightenment**

Science, technology, and medicine and their social and cultural interrelationships in the eighteenth and early nineteenth centuries. The modern agenda; nature, knowledge, and progress. Early social science.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

and outreach at these centers.

HIST 6234:

Advanced Topics in the History of Modern Science, Technology and Medicine

Variable topics in history of science, technology, and medicine after 1800, such as the atomic age; space science; science, technology, and institutions; scientific and technological medicine; and environmental history. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HUMAN DEVELOPMENT

Anisa Zvonkovic, Head

Professors: Katherine Allen; Joyce Arditti; Rosemary Blieszner; Marcie

Boucouvalas; Victoria Fu; Eric McCollum; Peggy Meszaros; Fred Piercy; Karen

Roberto; Anisa Zvonkovic;

Associate Professors: Mark Benson; Megan Dolbin-MacNab; Mariana Falconier;

April Few-Demo; Angela Huebner; Shannon Jarrott; Scott Johnson; Christine

Kaestle; Kee Kim; Jyoti Savla; Cynthia Smith;

Assistant Professors: Erika Grafsky;

Alumni Distinguished Professor: Rosemary Blieszner;

Research Scientists: Isabel Bradburn;

William E. Lavery Professor: Peggy Meszaros;

Graduate Contact: ksurface@vt.edu

Department Website: <http://www.humandevlopment.vt.edu>

All graduate programs in the Department of Human Development integrate research-based knowledge with human-based values. We promote the quality of life of our society's most basic elements-individuals, families, and communities We value collaboration, inclusion, equity, empowerment, passion, and celebration in our work. We also embody a lived commitment to the land grant mission of integrating teaching, research, and outreach.

SPECIAL FACILITIES

Students have opportunities to apply knowledge in real-world settings. The Blacksburg campus is home to three such settings: The Child Development Center for Learning and Research, Adult Day Services, and the Family Therapy Center. The NVC campus is home to the Center for Family Services. Graduate students complete course work, internships, practicum, and assistantships related to research, teaching,

Locations, Goals, Specific Research Areas

Locations: Blacksburg and Falls Church The Department of Human Development offers programs leading to a master's (M.S.) or doctoral degree (Ph.D.) in Human Development with emphases on childhood and adolescence, adulthood and aging, adult learning and human resource development, family studies, and marriage and family therapy. Graduate programs are available at both the main campus (Blacksburg, VA) and the National Capital Region campus (Falls Church, VA). Goals of Facilities and Resources Programs in the Department of Human Development integrate research-based knowledge with human-based values. We promote the quality of life of our society's most basic elements-individuals, families, and communities. We value collaboration, inclusion, equity, empowerment, passion, and celebration in our work. We also embody a lived commitment to the land grant mission of integrating teaching, research, and outreach. Distinctive features of our graduate programs include: A commitment to the highest standard of relevance-research, teaching, and outreach that meets real needs of real people; A faculty that is both nationally known and committed to nurturing the best in our students; Opportunities to work closely with faculty and peers on research, journal articles, and professional presentations; Opportunities to apply knowledge in real-world settings Specific Research Areas Students have opportunities to gain valuable research training working with Human Development faculty. A total of 18 areas of research interests are shared among the doctoral faculty including: Adolescence and emerging adulthood Attachment across the lifespan Clinical practice & supervision Cultural diversity Early childhood and intervention Evaluation research Family & couple dynamics Family diversity, LGBTQ, feminism Family dynamics & parenting Gender relations Gerontology & aging studies Health Intergenerational International studies Qualitative methodology Quantitative statistical methodology Sexuality across the life course Social & cultural systems

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (500.0), Quantitative (500.0)

The Human Development Master's program at the Blacksburg Campus requires 30 credits, which includes 6 credits of internship. Each core course includes a Portfolio Project. Students also present at the HD

Master's Symposium. The thesis is optional. The Master's degree program in Marriage and Family Therapy at the National Capital Region campus requires 51-54 credits. The post-master's certificate in Marriage and Family Therapy at the Northern Virginia campus requires 21 credits. Students pursuing the master's degree through the Adult Learning and Human Resource Development (ALHRD) program at the National Capital Region Campus complete 33 hours of graduate study and a thesis or project work.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (500.0), Quantitative (500.0)

The Marriage and Family Therapy Ph.D. program at the Blacksburg campus admits students with a master's degree. Students complete a minimum of two years of coursework and one year of internship. The Ph.D. programs in Adult Development and Aging (ADA), Child and Adolescent Development (CAD), and Family Studies (FS) admit students who hold either bachelor's or master's degrees. Bachelor's level students complete the master's thesis and degree en route to the Ph.D. Master's level students receive transfer credit for related graduate courses. Along with required courses, doctoral students participate on research teams, engage in teaching mentorship, and complete a dissertation.

GRADUATE COURSES (HD)

HD 5104:

Adult Development and Aging I: Individual Development

Introduction to theories and methods used to study adult development and aging. Provides students with a thorough grounding in the scholarly literature in regard to the demographic, biological, functional, psychological, and social aspects of aging with a specific focus on individual development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5114:

Adult Development and Aging II: Interpersonal Issues

Interpersonal and social development across the adult phases of the life cycle. Integration of theory and research as it pertains to family and friend networks, living arrangements, diverse family forms, and critical

life events such as widowhood.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5104

Corequisite(s):

HD 5134:

Contemporary Issues in Aging

Seminar that examines literature and research on selected issues in gerontology, such as long-term care, work and retirement, older women, demographic variations of the aging experience, grant writing, intergenerational programs, administration of community based services, and adult education programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5144:

Seminar In Gerontology

Introduction to a wide variety of research, policy, and professional issues in gerontology, and programs and services for aged adults.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5214:

Theoretical Foundations of Child Development

Selected theories related to child development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5224:

Social and Emotional Development in Children

Review of research related to social and emotional development of the child from birth through middle childhood. I

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): HD 5214
Corequisite(s):

HD 5234:

Cognitive Development: Infancy Through Adolescence

In-depth study of developmental research and theoretical approaches to cognitive development.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): HD 5214
Corequisite(s):

HD 5324:

Marriage and Family Relationships

An introduction to the literature in family studies with emphasis on integration of concepts and current developments in the field.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HD 5334:

Theories in Marriage and the Family

Overview of theory construction; in-depth study of various theories of family development and interaction; application of theoretical frameworks to research and analysis of the family; and consideration of the explanatory value of theory when examining the relationship of the family to the larger society. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): HD 5314 OR HD 5324
Corequisite(s):

HD 5344:

Perspectives On Human Sexuality

Interdisciplinary historical consideration of writings, research, theory, and application of knowledge related to human sexuality. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HD 5404:

Systems Theory and Family Therapy

Theory development and basic underlying assumptions of a systems framework to marriage and family therapy. Emphasis is on conceptualizing human problems as they are related to the functioning of systems.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HD 5414:

Family Stress and Crisis Intervention

Review of strategies for intervening in crisis situations along with examination of the operation of stress and stress-producing experiences in individuals and families.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

HD 5424 (EDCO 5424):

Life Span Development

Stages of individual development as they occur in the context of the family life course. Overview of current developmental theories. Impact of race, gender, and class on cultural views of developmental norms.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):
Corequisite(s):

HD 5434:

Clinical Marriage and Family Therapy I

233 Underlying philosophy, theory and practice of the Structural and

Strategic approaches to marital and family therapy. I, II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5404

Corequisite(s):

HD 5444:

Clinical Marriage and Family Therapy II

This course comprises three distinct parts. The first part examines the approaches to family therapy that have been labeled "Constructivist Approaches." The second part examines Emotionally Focused Therapy. The final part involves an in-depth look at the Metaframeworks Model developed at the Institute for Juvenile Research in Chicago, which integrates various schools of marriage and family therapy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5404

Corequisite(s):

HD 5454:

Clinical Marriage and Family Therapy III

Emphasis is on interrelationships between mind, body, environment, and social aspects of behavior in the context of the family system. The focus will be on the process of diagnosis and treatment in the family context. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5404, HD 5434, HD 5444

Corequisite(s):

HD 5464:

Adolescent Development

Advanced study of the physical, cognitive, social and emotional development of the adolescent with emphasis on theoretical issues, research findings, and application of theory and research. Implications for education are highlighted.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5474:

Professional Seminar In Marriage and Family Therapy

Focuses on the major ethical, legal, and professional issues faced by those in the field of marriage and family therapy. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5484:

Clinical Marriage and Family Therapy IV

Issues of treatment related to specialized content areas of family therapy. Focus on topics such as: sexual dysfunction, divorce counseling and mediation, the abusive/violent family, addicted family members, suicidal problems, ethical and professional issues in treating marriages and families. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5434, HD 5444

Corequisite(s):

HD 5514:

Research Methods

Introductory course in research methodology for the social sciences: formulation of a research problem, design, sampling, data collection, measurement, data analysis, interpretation, and writing the research report. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5614:

Human Development Theory: Literature and Applications

Introduction to major theories of human development and application of these theories to understanding and improving the well being of children, adults, couples, and families within complex social systems. Portfolio project: Preparation of a theoretically driven literature review. I.

Credit Hour(s): 3

234 Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5624:

Professional Practices in Human Development

Interdisciplinary approaches to professional practices in the delivery of human services. Emphasis on human service delivery to families and communities, management practices, and professional development. Portfolio project: Professional management and leadership assessment. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5634:

Legislation and Policy in Human Development

This course provides a context for students to consider in-depth connections between government, policy, and individuals and families throughout the life course. Emphasis is placed on learning through individual study, analysis, and reflection. Students will engage in an advanced exploration of substantive and theoretical issues that relate to the development and implementation of human development policies affecting children, adults, couples, and systems. Portfolio project: Policy analysis paper based on a specific topic, position papers on policy topics. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5614, HD 5624, EDRE 5404

Corequisite(s):

HD 5644 (PHS 5644):

Program Development and Evaluation in Human Development

Principles of development, implementation, and sustainability of programs for children, youth, adults, and families, and methodologies used to evaluate program effectiveness. Portfolio project: Program development and program evaluation. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5614, HD 5624, EDRE 5404

Corequisite(s):

HD 5654:

Grant Development and Administration in Human Development

Overview of the methods and procedures for developing competitive grant proposals. Students learn basic grant writing skills that include identifying and seeking funding sources, preparing a fundable grant proposal, building a budget, and managing a funded project. Portfolio project: Development of actual grant proposal for an organization or special project. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5614, HD 5624, EDRE 5404

Corequisite(s):

HD 5664:

Internship in Human Development

Provides consultation and seminar dialogue for advanced master's student in Human Development as they undertake experiences in a supervised field setting. Possible settings span an array of human development agencies focused on children, adults, and families. Experiences include activities of a regularly employed professional in the setting accompanied by periodic seminar meetings.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): HD 5634, HD 5644, HD 5654, EDRE 5404

Corequisite(s):

HD 5714:

Current Topics in Human Dev

Advanced seminar on current topics in human development. May be repeated with different topic content for a maximum of 9 credits. Prerequisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5724:

Overview of the conceptual, clinical, and empirical advances in couples therapy. Focus of course will be on using current research on couple interaction and evidence-based marital therapy to assess and treat couples.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5404

Corequisite(s):

HD 5734:

MFT Techniques

This course introduces the student to the requisite skills for beginning practicum. Students will examine the role of theory in practice, the differences between process and content, the use of process in clinical work, and the impact of gender, ethnicity, and therapist's self perception on the therapy process. The course will also review "nuts and bolts" of therapy (i.e., writing appropriate clinical notes, identifying risk issues, etc.). Admission to the MFT Clinical Program is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5404, HD 5434

Corequisite(s):

HD 5744:

Special Topics in MFT

In-depth study of selected topics in marriage and family therapy (e.g., medical family therapy, play therapy, spirituality and family therapy). Focus of course will be on reviewing current research on the specific issue and developing treatment strategies for individuals, couples, and families. May be repeated for credit with different content for a maximum of 9 credit hours. For Northern Virginia Students Only.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5404

Corequisite(s):

HD 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5964:

Practicum

Practicum experiences in departmental options under supervision. (Maximum 15 percent of student's graduate program).

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

HD 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HD 5994:

Research And Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HD 6004:

Prof Development Seminar

Review and critique of professional issues in the field of human development related to research and scholarship, pedagogy, outreach,

and service. May be repeated.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 6014:

Theory Construction in Human Development

Concepts, principles, and processes of theory construction; paradigms in human development and family studies; development of definitions; assumptions; propositions, and hypotheses; criteria for evaluating theory; and construction of theoretical statements. The pre-requisite EDRE 6605 may be substituted for an equivalent course in research methods and statistics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5614, EDRE 6605

Corequisite(s):

HD 6114:

Theory And Research In Aging

Advanced course in gerontology. Review and critique of theoretical constructs and their research applications. Appropriate research designs and procedures for studying development in adulthood and old age. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5104, HD 5114

Corequisite(s):

HD 6214:

Parent-Child Interaction

Review of theories and research in parent-child interaction from birth through adolescence and exploration of practical application in various settings.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 6314:

Seminar In Family Studies

Introduction to literature and research in selected areas of family studies.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 6324:

Process In Relationships

Advanced course on process in adult relationships with focus on properties, types, diversity, development, and maintenance of close relationships between adults.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5324

Corequisite(s):

HD 6404:

Advanced Systems Theory & Family Therapy

Advanced investigation of the development and conceptual basis of systems theory with application to marriage and family therapy. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 6414:

Advanced Traditional Models In Marriage and Family Therapy

Advanced study and application of Systemic, Bowenian, and Narrative family therapy models within the profession of marriage and family therapy. Prior training in general systems theory, family therapy theories, and therapeutic experience in family therapy required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 6404

Corequisite(s):

Advanced Experiential Models in Marriage and Family Therapy

Underlying theory and practice of couple and family therapy from experiential therapy models. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 6404, HD 6414

Corequisite(s):

HD 6434:**Advanced Diagnosis and Assessment**

Comprehensive and advanced study of psychopathology and its assessment and diagnosis from a relational context. The traditional diagnoses of mental disorders are stated in the context of interactional systems, gender, race, and cultures. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 6404, HD 6414, HD 6424

Corequisite(s):

HD 6444:**Advanced Contemporary Marriage and Family Therapy**

Advanced study of the profession of marriage and family therapy. This course will rotate topics and cover two advanced practice areas such as feminist therapy, sex therapy, or therapy with families with substance abuse or violence. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 6414, HD 6424, HD 6404

Corequisite(s):

HD 6464:**Clinical Supervision of Marriage and Family Therapy**

Underlying philosophy, theory, and principles of the process of supervising the practice of marriage and family therapy. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 6404, HD 6414, HD 6424

Corequisite(s):

HD 6474:**Advanced Professional Seminar In Marriage and Family Therapy**

Advanced understanding of the major ethical, legal, and professional issues faced by those in the field of marriage and family therapy. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 6484:**Marriage and Family Therapy Research**

Comprehensive overview of the major empirical research of marriage and family therapy. Prior training in family therapy theories and therapeutic processes required. A basic knowledge of quantitative and qualitative research methods required. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 6514:**Adv Research Methods**

Advanced level research methodology; examination of current procedures for studying individual development and family relationships. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HD 5514

Corequisite(s):

HD 6524:**Current Topics in Advanced Research Methods**

Discussions on emergent techniques used in contemporary methodological literature. Training in modern software for implementation of complex research methodologies. May be repeated with different topic content for a maximum of 4 credits. Pre: Graduate standing.

Credit Hour(s): 1 TO 4

Lecture Hour(s): 1 TO 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HD 7994:

Research And Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHILOSOPHY

Joseph Pitt, Interim Chair

Emeriti Faculty: Richard Burian; Harlan Miller;

Professors: James Klagge; Deborah Mayo; Joseph Pitt;

Associate Professors: Lydia Patton;

Assistant Professors: Benjamin Jantzen; Tristram McPherson; Michael Moehler;

Kelly Trogon;

Visiting Faculty: Ted Parent;

Adjunct Professors: James Garrison;

Graduate Coordinator: tzapata@vt.edu

General Contact: hollymb2@vt.edu

Graduate Program Director: critique@vt.edu

M.A. Program Website: <http://www.phil.vt.edu/ma/ma.html>

Student Handbook: <http://www.phil.vt.edu/ma/GradHandbook.pdf>

Placement Record: <http://www.phil.vt.edu/ma/placement.html>

The Department of Philosophy's M.A. program is one of the top terminal M.A. programs in philosophy in the United States. We offer core graduate training in philosophy in the broadly analytic tradition, with particular strengths in the history and philosophy of science and in ethics, social and political philosophy. Many of our students enter with the intention of enriching their philosophical background and then going on to Ph.D. studies elsewhere. We have been highly successful in placing our students in leading doctoral programs. Other students simply wish to gain a deeper knowledge of philosophy before going on to other disciplines or professions. In addition to the philosophy M.A., we participate in Ph.D. programs in Science, Technology and Society (which has a philosophy track), and in the Alliance for Social, Political, Ethical, and Cultural Thought.

SPECIAL FACILITIES

The Department of Philosophy has a computer lab for graduate students, as well as office space for all who are currently enrolled. There is also a small library and lounge for graduate student use.

Philosophy Facilities

The Department of Philosophy has a computer lab for graduate students, as well as office space for all who are currently enrolled. There is a small library and lounge for graduate student use.

DEGREES OFFERED

MA Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (600.0), Quantitative (650.0), Analytical (5.0)

The M.A. degree requires a minimum of 30 credit hours of graduate level work. Students may complete the requirements for the M.A. degree through either the thesis or non-thesis tracks. Students pursuing the thesis track write a thesis and take at least 24 hours of regular coursework. Students pursuing the non-thesis track take at least 27 hours of regular coursework and complete a set of comprehensive exams at the conclusion of the two year program.

GRADUATE COURSES (PHIL)

PHIL 5204:

Topics in the History of Philosophy

An advanced course focusing on particular topics in the history of philosophy. Special emphasis will be placed on ideas and disputes which were historically influential and continue to be philosophically significant. Consent required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5204G:

Intermediate Philosophy of Mind

Current issues in the philosophy of mind, such as relation of mind and body, status of the mental, knowledge of own's own and other minds, personal identity, consciousness, mentality of animals and machines, topics in the philosophy of psychology. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5214G:

Intermediate Metaphysics

Examination of 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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5224G:

Intermediate Epistemology

Theory of knowledge. Exploration of topics including the foundations (or lack of foundations) of knowledge, the role of experience in knowledge, whether knowledge of the present and the nearby gives us reasons for beliefs about the future, the past, or about events far away, and related issues. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5304G:

Intermediate Topics in Social and Political Philosophy

Study of topics such as distributive justice, equality, exploitation, alienation, individual rights, anarchy, constitutional government, the justification of political authority, and liberation. Topics to be announced each semester course is offered. May be repeated with different content for a maximum of 6 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5305 (STS 5305):

Main Themes in the Philosophy of Modern Science and Technology

Problems, literature, and schools in the philosophy of science and technology. 5305: explanation and confirmation; 5306: theory change. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHIL 3505

Corequisite(s):

PHIL 5306 (STS 5306):

Main Themes in the Philosophy of Modern Science and Technology

Problems, literature, and schools in the philosophy of science and technology. 5305: explanation and confirmation; 5306: theory change. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHIL 5305

Corequisite(s):

PHIL 5324:

Metaethics

A systematic examination of metaethics, the branch of philosophical ethics that addresses questions about the nature of ethical discourse and its objects. Investigation of such issues as the meaning of ethical terms and judgments, the nature and grounds of ethical truth, the possibility of ethical knowledge, the rationality of ethical behavior, and the relations between ethical and scientific inquiry. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5334:

Normative Ethics

A systematic examination of normative ethics, the branch of philosophical ethics that addresses questions about how one should live. Investigation of factors relevant to moral rightness or wrongness, goodness or badness, and the theories that attempt to articulate the complex relations and interactions among them. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

240 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5344:

History of Ethics

Examination of the work of selected figures representative of important positions in the history of ethical theory from the Classical Age to the modern period. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5505:

Symbolic Logic

Modern deductive symbolic logic and its metatheory. 5505: Development of a system of first order logic. Truth functional sentential logic, monadic predicate calculus with identity. Proof techniques and translation

between natural and artificial languages. 5506: Logical metatheory: consistency, completeness, and decidability of logical systems. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5506:

Symbolic Logic

Modern deductive symbolic logic and its metatheory. 5505: Development of a system of first order logic. Truth functional sentential logic, monadic predicate calculus with identity. Proof techniques and translation

between natural and artificial languages. 5506: Logical metatheory: consistency, completeness, and decidability of logical systems. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5604G:

Intermediate Philosophy of Biology

This course is designed primarily for philosophy students with a strong

interest in biology or biology students with philosophical interests. 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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5614G:

Intermediate Philosophy of Science

An examination of the structure and methodology of science as well as key concepts such as explanation, confirmation, realism, and instrumentalism. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5904:

Project And Report

Only for students pursuing a Master of Arts degree with a non-thesis option. Variable credit course.

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHIL 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

PHIL 5984:

Special Study

241 Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHIL 6014:

Special Topics in Philosophy

Close examination of a discipline, topic, or group of questions from a major philosophical tradition. Such areas as philosophy of language, philosophy of logic, and philosophy of mathematics, and such issues as causation, the nature of space and time, mental representation, logical positivism, and the linguistic turn will be examined. May be repeated for credit, with permission and different content, for a maximum of 12 hours. Completion of at least one of the philosophy M.A. core courses required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 6204:

Advanced Topics in the History of Philosophy

Intensive study of a particular figure, school, or group in the history of philosophy, in cultural and theoretical context, such as Socrates in the Athenian "polis," Stoicism in the Hellenistic age, or Hume and the Scottish Enlightenment. May be repeated for credit, with permission and different content, for a maximum of 12 hours. Completion of at least one of the philosophy M.A. core courses required. |

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 6224 (ASPT 6224):

Distributive Justice

Influential contemporary theories of distributive justice. Social, political, ethical, and cultural dimensions of distributive questions. Utilitarianism, liberalism, libertarianism, pluralism, multiculturalism, autonomy, rights, needs, (global) egalitarianism, and (global) poverty. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHIL 6314 (STS 6314):

History of the Philosophy of Science

Philosophers of science from 1650 to 1900 with particular attention to the historical development of views about the methods of induction and hypothesis and accounts of theory testing. |

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHIL 5305, PHIL 5306

Corequisite(s):

PHIL 6324:

Advanced Topics in Ethics and Political Philosophy

A seminar closely examining a topic or group of topics in moral, social, or political theory. Such issues as the foundations of ethics, practical reason, the concept of 'virtue', political obligation, the bounds of moral and political community, paternalism, liberty, and privacy will be explored. Views considered may include moral realism and antirealism, contractarianism, egalitarianism, libertarianism, and communitarianism. May be repeated for credit, with permission and different content, for a maximum of 12 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PHIL 5334 OR PHIL 5344

Corequisite(s):

PHIL 6334 (STS 6334):

Advanced Topics in Philosophy of Science

Variable topics in advanced philosophy of science, including major theories of scientific explanation and their criticisms; philosophical foundations of statistics; naturalized philosophy of science. May be

repeated for credit, with permission and different content, for a maximum of 12 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

POLITICAL SCIENCE

Timothy Luke, Chair

Emeriti Faculty: Richard Rich; Charles Walcott;

Professors: Francois Debrix; Karen Hult; Ilya Luciak; Timothy Luke; Charles Taylor; Edward Weisband;

Associate Professors: Clair Apodaca; Bettina Koch; Chad Lavin; Deborah Milly; Wayne Moore; Scott Nelson; Ioannis Stivachtis; Laura Zanotti;

Assistant Professors: Ryan Briggs; Caitlin Jewitt; Rohan Kalyan; Jason Kelly; Dennis Medina; Luke Plotica; Besnik Pula; Andrew Scerri;

Adjunct Professors: Adam Newmark; Lynita Newswander;

Affiliated Faculty: Laura Jensen; Joel Peters; Georgeta Pourchot; Patrick Roberts; Gerard Toal;

University Distinguished Professor: Timothy Luke;

Edward S. Diggs Endowed Chair in the Social Sciences: Edward Weisband;

General Contact: jenkin04@vt.edu

Student Handbook:

http://www.psci.vt.edu/political_science/graduate/brochure.pdf

Graduate Site: http://www.psci.vt.edu/political_science/graduate/index.html

The Master of Arts in Political Science was established in 1969. Currently, the program enrolls 10 to 15 full-time students on campus each year and approximately 50-60 off-campus in the On-Line Master of Arts in Political Science Program (OLMA/PSCI). This relatively small scale provides excellent opportunities for close student-faculty interaction in both the residential and on-line degree programs. The Master of Arts Program covers all sub-fields of the discipline, and it prepares students for careers in academe, government, non-profit and for-profit organizations. It is especially well suited for students who want to acquire sophisticated theoretical and analytical skills before either pursuing a doctoral degree in political science or entering careers in public or private research organizations. The usual course of study is four semesters of full-time graduate work. The first three semesters are used primarily for required foundation courses and elective coursework while the fourth is used to write a master's thesis. In recent years, M.A. students in political science have enrolled in this program from a wide variety of American colleges and universities. Students have also entered the M.A. program from a number of other countries including Argentina, Austria, Bolivia, Brazil, Canada, China, England, France, Germany, Greece, India, Ireland, Israel, Mexico, Norway, Portugal,

Romania, Scotland, Sweden, Switzerland, and Turkey. Recent graduates have entered doctoral studies in Ph.D. programs at Arizona, Arizona State, California-Berkeley, California-Irvine, California-San Diego, Colorado State, Connecticut, Delaware, Denver, Duke, Florida State, Georgia, Indiana, Iowa, Johns Hopkins University, Kentucky, London School of Economics, Massachusetts-Amherst, Maryland, Miami, Minnesota, Michigan State, Nebraska, North Carolina, Penn State, Pittsburgh, Purdue, Ohio State, Oregon, Oxford, Strathclyde, University of South Carolina, SUNY-Albany, SUNY-Stony Brook, Syracuse, Texas A&M, Texas-Austin, Washington University-St. Louis, Utah, Wisconsin, Virginia Tech, and Virginia. Other graduates have taken professional positions in government agencies, political organizations, research institutes and non-profits.

SPECIAL FACILITIES

The computer lab for Political Science MA students is located in 504 Major Williams Hall.

Computer Lab

The Political Science Research Lab is open to graduate students 24 hours a day. It contains several computers linked to the Internet and campus networks. A variety of research and word processing software is available for these machines. Knowledge of these resources combined with emphasis on quantitative and qualitative methods are assets to students who anticipate working in a public or private agency or at an educational institution. Students also have access to a wide variety of computerized data sets through the University's membership in the Intercollegiate Consortium for Political and Social Research (ICPSR).

DEGREES OFFERED

MA Degree

Offered In (Virtual, Blacksburg)

TOEFL

Paper: (620.0), Writing (4.5)

Computer: (260.0), Writing (4.5)

iBT: (105.0), Writing (26.0)

GRE required

The degree requirements for the MA are 21 hours of coursework and 9 hours of Thesis and Research. Three classes are required: PSCI 5115-Research Methods I, 5116-Research Methods II, and 5214-Contemporary Political Theory (total of 9 cr.) and 4 electives (12 cr.).

GRADUATE COURSES (PSCI)

PSCI 5115 (GIA 5115):

Research Methods

The purposes, problems, and strategies of political science research, emphasizing concept and hypothesis formulation, operationalization, research design, data collection techniques, data processing, and

multivariate data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5116 (GIA 5116):

Research Methods

The purposes, problems, and strategies of political science research, emphasizing concept and hypothesis formulation, operationalization, research design, data collection techniques, data processing, and multivariate data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5115, STAT 5654

Corequisite(s):

PSCI 5124:

Advanced Research Issues

Advanced work in research methods including the conceptual issues underlying measurement and data analysis. Covers appropriate techniques for addressing those issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5115, PSCI 5116

Corequisite(s):

PSCI 5164 (GIA 5164) (UAP 5164):

Collaborative Governance and Civil Society

Theoretical foundations of collaborative policy and governance approaches are examined. Strategies and methods for forming and sustaining collaborative coalitions are discussed. Case studies are used to illustrate the effectiveness of collaborative approaches in different policy domains.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5214 (GIA 5214):

Contemporary Political Theory

Selected topics in contemporary political theory, including different models of social science inquiry and the use of basic concepts like power, ideology, rationality, and the state in the study of politics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5224:

Alternative Perspectives in Political Theory

Analysis of selected perspectives on politics including: rational choice theory, critical theory, neo-marxism, neo-conservatism, post-industrialism, and post-structuralism.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5244:

Constitutionalism in Theory and Practice

The course investigates theories and practices of constitutionalism, both within the United States and more generally. It frames a number of questions about what characterizes constitutionalism as a distinctive theory of politics, while also examining the construction, maintenance, change, and destruction in practice of constitutional orders, constitutions, constitutional institutions, and other constitutional norms. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5254 (GIA 5254):

Global Conflicts

Examines theoretical issues in the study of global conflicts. Reviews theories of nationalism, states and territory as factors. Examines dynamics of contemporary conflicts from different regions of globe as case studies illustrating theoretical issues. Reviews role of leaders in

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5264:

Global Change & Local Impacts

All jurisdictions, national, regional, or local, function in an interconnected global market. Understanding the structure and interactions within the global market and the impacts therein is the focus of PSCI 5264.

Thematic topics include a review of welfare state functions, privatization, decentralization, and nonprofit organizations and their relation to global market dynamics. Upon completion of the courses, students will have and understanding of how global forces influence local areas and how local leaders have developed strategies to cope with their position in an increasingly global market.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5284 (GIA 5284):

Transnational Migration

Overview of the dynamics, policies, governance, and citizenship regimes associated with the phenomenon of transnational migration. The course will emphasize local, national, and supranational examples and comparisons to explore these themes. Graduate standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5314:

Legislative Branch

The legislative process in American state and federal governments including recruitment of members, organization and functioning of legislative systems, and relations with both constituents and other branches.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5324:

The Executive Branch

The executive office and bureaucracy of American state and federal governments including recruitment, organization of executive branches, decision making, leadership styles, and relations with other branches.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5334:

The Judicial Branch

The American judicial system including recruitment of personnel, uses of the courts, judicial policy, relations with other branches, judicial behavior, and the impact of court decisions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5344:

Political Behavior

Approaches to the study of political behavior including political psychology, rational choice, biopolitics, socialization, communication, public opinion, and political participation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5354 (GIA 5354):

Public Policy Analysis

Approaches to policy analysis and program evaluation including the techniques appropriate to various stages of the policy process.

Credit Hour(s): 3

Lecture Hour(s): 3

245 Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5364 (GIA 5364) (STS 5364):

Public Ecology

Examines policy developments and practices that move beyond the conceptual divisions and policy operations begun during the 1970's, which largely divided the more natural science- based environmental sciences from social science-based environmental based studies. Mixes the insights of life science, physical science, social science, applied humanities, and public policy into a cohesive conceptual and operational approach to environmental protection in the 21st century. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5374 (GIA 5374):

Electronic Governance

Examines applications of information technology in government from the point of view of governments and citizens. Survey of the relationship between e-government e-democracy and of government management techniques. Explores problematic issues related to e-government, such as privacy, the digital divide, and information security.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5214, PSCI 5554 OR UAP 5564

Corequisite(s):

PSCI 5384:

Identity Migration and Place

Place-based identities and intersectional inequalities. Influence of these interrelated dimensions on the study of forced and voluntary migrations within and across national borders, and such discourses as home, belonging, nationhood, and citizenship.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): WGS 5114

Corequisite(s):

PSCI 5414:

Industrial Democracies

Political patterns and processes of development in selected democracies in Europe, North America, and Asia emphasizing the political problems of contemporary industrial societies and their likely evolution in a "post-industrial" era.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5424:

Communist and Post-communist Systems

Political processes and developmental trends in communist and post-communist systems in Russia and other CIS states, Eastern Europe, the People's Republic of China, and the Third World. Current economic, political, and social issues and their likely development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5434 (GIA 5434):

Politics of Developing Areas

Political structures, economic growth, and cultural frameworks of developing nations in Asia, Africa, and Latin America emphasizing the political and economic challenges of industrial development in a global economy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5444 (GIA 5444):

International Politics

Theories of international organizations and relations among nations focusing on research in foreign policy formulation and implementation, international integration, conflict resolution, and global political economy.

Credit Hour(s): 3

246 Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5454 (GIA 5454):

Advanced Topics in Information Technology and Public Policy

In-depth study and critical evaluation of selected complex issues related to information technology, society, governance, and public policy.

Focused attention is given to theoretical and methodological foundations of the area of inquiry and to specific domains of policymaking and implementation. Topics will be selected from IT-related issues in such areas of concern as: cities, local communities, nonprofit organizations, governments, and global networks. May be repeated on a different topic.

Must meet prerequisite or have permission of the instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): UAP 5564

Corequisite(s):

PSCI 5464:

Critical Security Studies

Provides an overview of the critical study of security in world politics.

Introduces alternative conceptualizations of security to the military-focused, state-centric security/strategic studies. Considers constructivist, post-structuralist and critical theoretic attempts to conceptualize the nature of security. Compares and contrasts these approaches with widely-accepted understandings of security in light of key debates in contemporary security studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSCI 5444

Corequisite(s):

PSCI 5474:

Global Governance

Examination of the norms, institutions and practices developed by the international community to address systemic global governance problems: genocide, failed states, transnational corruption, displaced persons, AIDS, poverty. Role of United States in World community examined. Power of international organizations versus states. Capacity problems of both. Future of United Nations and global governance considered. Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5484 (HIST 5484) (GIA 5484):

Contemporary American Foreign Policy

Covers U.S. foreign policy during the Cold War, the stalemate with the Soviet Union, armament and arms control, containment and deterrence, detente and Reaganism, and the end of the Cold War. Briefly covers events from 1989 to the present. Designed for students with an interest in foreign policy and global affairs. Prereqs or instructor's permission.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5214, PSCI 5444

Corequisite(s):

PSCI 5504 (GIA 5504) (UAP 5504):

Discourse Analysis

Examines the key theoretical sources and major practical applications of discourse analysis as a contemporary social science methodology.

Origins, major variants, and critical uses of discourse analysis in cultural studies, semiotic methods, policy analysis, and organizational communication techniques also are considered. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5514 (WGS 5644):

Global Security

Security examined as an essentially contested concept. Traditional national security and emergent global security discourses and agendas explained. Security institutions and organizations analyzed. Questions of power, identity and representation examined as factors delimiting security conceptions, practices and agendas. Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

247 Prerequisite(s): GIA 5444 OR UAP 5264 OR PSCI 5444

Corequisite(s):

PSCI 5524:

U.S. Foreign Policy After September 11

Course offers a historical and analytical evaluation of U.S. foreign policy after this epochal change especially with regard to the war on terror, geopolitics in the Middle East, and relations with new global powers after the end of the Cold War.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5484

Corequisite(s):

PSCI 5534 (GIA 5534):

Regionalism and Political Development

Provides a systematic review of regional organizations, the theories and factors that explain their recent emergence and an analytical framework for studying regional policy objectives such as peace and security, economic growth, environmental protection and the pursuit of human rights. Regional variations between Europe, Latin America, Asia, Africa and the Middle East are examined.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5444 OR PSCI 5444

Corequisite(s):

PSCI 5554:

Culture, Politics and Society in Network Environments

Historical origins, institutional foundations, and theoretical interpretations of cultural, political, and social interaction through computer mediated communication are examined. Particular attention is given to new types of discourse, sources of power, and structures of society at all geographical levels in global computer and communications networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5564 (WGS 5564) (GIA 5564):

Women and Globalization

Feminist theoretical paradigms the analyze impacts of globaliztion on

women and girls. Impacts of globalization on households and families.

Relationship between globalizing processes and gender inequalities.

Addresses feminist controversies and women's transnational resistance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5574 (GIA 5574):

Arts, Culture and Society

Considers the role of the arts in society, including architecture, music companies, or theater productions to heritage sites, science museums, and art galleries. Effective arts policy in revitalizing urban economies also examined. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5584 (GIA 5584) (UAP 5584):

Environmental Politics and Policy

Course provides a broad introduction to the key ideas, actors and institutions related to environmental politics and policy in the United States, with some coverage of global issues. It is intended to provide students with basic interdisciplinary knowledge and an intellectual framework for understanding and thinking critically about environmental politics and policy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5614 (GIA 5614):

Understanding The Israeli Palestinian Conflict

Dynamics of the Israeli-Palestinian conflict. Critical issues that underlie the conflict and divide Israel and the Palestinians. Diplomatic efforts aimed at resolving the conflict. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5624:

Conflict Res & Peace Building

Comprehensive guide to contemporary conflict resolution. Strategies and approaches for mitigating and resolving conflict. Process of conflict transformation and reconciliation. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5634:

International Human Rights: Law, Politics and Practice

Theory and practice of international law for the protection of human rights. Legal instruments and institutions designed to protect international human rights and legal remedies available to victims of violations. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5644 (WGS 5644):

Women's Rights as Human Rights

International mechanisms for development and protection of women's human rights and their legal, political and cultural dimensions. Methods of strengthening and improving these mechanisms to prevent and respond to women's human rights violations. Pre: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

PSCI 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

PSCI 6114 (GIA 6114):

Critical Geopolitics

Critical analysis of geopolitics as spatial discourse about world politics. Examines major concepts in critical geopolitics. Critically reads colonial, fascist, Cold War and post-Cold War geopolitical discourses. Discusses geopolitical knowledge in popular culture. Reviews latest research in the field of critical geopolitics. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5444 OR PSCI 5444 (UG)

Corequisite(s):

PSCI 6124:

Topics in Security Studies

Surveys the interface of globalization and security and the changing paradigm of security within global society. Reviews the impact of globalization on traditional understandings of state security and provides an advanced understanding of the emerging challenges and threats to human and state security.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): GIA 5444 (UG) OR GIA 5444 OR PSCI 5444 (UG) OR PSCI 5444 OR GIA 5514 (UG) OR GIA 5514 OR PSCI 5514 (UG) OR PSCI 5514

Corequisite(s):

PSCI 6134:

Topics in Conflict Analysis

Provides a comprehensive guide to the understanding of contemporary global conflicts and conflict resolution. Reviews the field of conflict analysis, demonstrates the various approaches to conflict resolution and explores the dynamics of conflict settlement.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5254 (UG) OR GIA 5254 OR UAP 5254 (UG) OR UAP 5254 OR PSCI 5254 (UG) OR PSCI 5254

Corequisite(s):

PSCI 6144:

Topics in Global Governance

Provides a comprehensive guide to the understanding of contemporary power pressures and responses to global economic and financial change along with its political and social repercussions. Reviews the fields of international political economy, demonstrates the various approaches to adherence and resistance to globalization, and explores the dynamics of the relationship between states and markets.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5034 (UG) OR GIA 5034 OR UAP 5034 (UG) OR UAP 5034 OR PSCI 5034 (UG) OR PSCI 5-34

Corequisite(s):

PSCI 6204:

Theories of Globalization

Examination of past and present eras of globalization through various

theoretical perspectives. Addresses colonialism and emergence of western models for development of poor countries. Controversies about impacts of current globalization on the nation-state, cultures, ecosystems, and racial/ethnic/gender inequalities. Explores present trends, such as globalization of agriculture and food systems, industrial production, migration, human rights, and anti-globalization resistance. Pre-requisite may be substituted for any equivalent 5000 level international course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5264 OR GIA 5264

Corequisite(s):

PSCI 6214 (GIA 6214):

Democracy Beyond the Ballot

Forms of ultra or enhanced democracy outside of state institutions, particularly those developing in third sector organizations, theories of democracy and research on functioning deliberative democracies at the grassroots level, in societal or international institutions. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5034 OR UAP 5034 OR PAPA 5034 OR GIA 5164 OR UAP 5164

Corequisite(s):

PSCI 6224 (GIA 6224):

Competing Conceptions of the Third Sector

Competing theories and conceptions of the third sector in relation to the for-profit firm and the state with international perspectives on voluntary grassroots action challenges and societal transformation. Integration of theoretical and research literatures in the field. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5034 OR UAP 5034 OR PAPA 5034 OR GIA 5164 OR UAP 5164

Corequisite(s):

PSCI 6234:

Pre-Mod Chr & Isl Pol Theory

Analysis of pre-modern Christian and Islamic political thought approached as comparative theory. Integrates different genres (administrative handbooks, ethical writings, and philosophical treatises) from various Christian and Islamic cultural and religious settings. Pre-requisite: Prior completion of at least one 5000 level course in political theory, philosophy or an equivalent course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PSCI 6244:

History, Culture, and Politics of the Internet

Explores a variety of social factors, past and present, that have affected the way we make, use, and think about computers and the Internet.

Begins with the origins of the Internet and the people who shape this technology, from military strategists to hackers. Examines the ways diverse groups interact and build communities online and how cultural norms about race and gender shape the ways we participate in the world of computing. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 6544:

Science, Technology, and Labor

Examines issues of work, skill, and power in science and technology. Considers labor issues from a variety of perspectives, including social constructions of expertise; effects of technical change on the organization of work; industrial automation and "deskilling"; race and gender in divisions of labor; "labor-saving" technology in everyday life; "invisible labor" in information systems; and work practices in the production of science. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PSCI 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

RHETORIC AND WRITING

Joseph Eska, Chair

Professors: Diana George; Bernice Hausman;

Associate Professors: Kelly Belanger; Sheila Carter-Tod; James Dubinsky; Carlos Evia Puerto; Shelli Fowler; Paul Heilker; Kelly Pender; Katrina Powell;

Assistant Professors: Elizabeth Mazzolini; Jennifer Sano-Franchini; Quinn Warnick;

Graduate Contact: pender@vt.edu

Graduate Contact: sallyw@vt.edu

Graduate Site: <http://www.english.vt.edu/graduate/PhD/>

The PhD Program in Rhetoric and Writing at Virginia Tech focuses on rhetoric in society. We study language use and rhetorical activity in public, academic, corporate, and governmental settings in a collective effort to engage pressing social and cultural issues from the perspective of rhetorical and writing studies. As faculty at a land-grant university, we seek students who want to engage in research into how rhetoric and writing can contribute to social progress, how literate practices create, circulate, and prioritize societal values and the public policies based on those values, and how rhetoric and writing empower and control access to power in these social systems. Our collective research agenda addresses rhetorical and social problems in such areas as: science and technology digital texts and publishing diversity and difference the environment scholarly inquiry medicine and disability education civic engagement globalized communication and commerce

SPECIAL FACILITIES

Center for the Study of Rhetoric in Society

<http://www.rhetoric.english.vt.edu/index.html>Our mission: To study the role of language in individual and social transformation.Our vision: To advance the study of rhetoric and writing through projects and

How do texts (digital, print, multimedia, visual, and verbal) and related communication practices mediate knowledge and action in a variety of social and professional contexts

Center for the Study of Rhetoric in Society

Our mission is to study the role of language in individual and social transformation. Our vision is to advance the study of rhetoric and writing through projects and partnerships that promote the public good. Our central research question is how do texts (digital, print, multimedia, visual, and verbal) mediate knowledge and action in a variety of social and professional contexts.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal, Quantitative, Analytical

Degree requirements will include 60 hours of graduate coursework past the bachelor's degree plus 30 hours of research and dissertation. Of those 60 hours of coursework, up to 30 may be transferred from an appropriate Master's degree. Because rhetoric and writing are inherently interdisciplinary subjects, this program invites students to complete some coursework in related fields such as Language and Literature, Communication, Science and Technology Studies, Political Science, Human-Computer Interaction, and Engineering Education, as well as courses in preparing the future professoriate offered by the Virginia Tech Graduate School. <http://www.english.vt.edu/graduate/PhD/require.html>

SCIENCE AND TECHNOLOGY STUDIES

Ellsworth Fuhrman, Head

Professors: Barbara Allen; Gary Downey; Ellsworth Fuhrman; Doris Zallen;

Associate Professors: Janet Abbate; Daniel Breslau; James Collier; Saul Halfon;

Ann Laberge; Eileen Patzig; Matthew Wisnioski;

Assistant Professors: Ashley Heflin; Philip Olson; Sonja Schmid;

Alumni Distinguished Professor: Gary Downey;

General Contact: slusserc@vt.edu

Student Handbook: <http://www.sts.vt.edu>

Science and Technology Studies explores the relationship between science, technology, and society using a variety of disciplinary and interdisciplinary approaches. Research in STS analyzes how society

affects the development and implementation of scientific, technological, and medical knowledges and practices and how scientific, technological, and medical pursuits affect society. The research and scholarly interests of STS faculty cross a wide range of disciplinary boundaries: some rely on fieldwork, others are immersed in historical or governmental archival research, while others develop social and conceptual analyses to answer theoretical or ethical questions. Graduate students in STS come from a wide range of backgrounds including the natural and physical sciences, engineering, numerous professional disciplines, liberal arts and humanities, history, anthropology, sociology, political science, and philosophy. Graduates emerge with an ability to identify and examine the conceptual, social, cultural, historical, and policy dimensions of science and technology. Courses leading to an M.S. or a Ph.D. in STS are available at two sites, Virginia Tech's main campus in Blacksburg and the National Capitol Region (NCR) in the greater D.C. metro area.

SPECIAL FACILITIES

Lane Hall

The STS administrative offices are located in 122 Lane Hall. Individual faculty offices are located in Lane Hall as well as other buildings on campus. The National Capital Region is located at 2054 Haycock Road, Falls Church, VA.

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

GRE

General Test: Verbal, Quantitative, Analytical

MS course requirements can be found on this website:

<http://www.sts.vt.edu/mscourses.php> PhD course requirements can be found on this website: <http://www.sts.vt.edu/masters.php> For further information, contact Carol Sue Slusser at slusserc@vt.edu

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

MS course requirements can be found on this website:

<http://www.sts.vt.edu/mscourses.php> PhD course requirements can be found on this website: <http://www.sts.vt.edu/masters.php> For further information, contact Carol Sue Slusser at slusserc@vt.edu

GRADUATE COURSES (STS)

Corequisite(s):

STS 5014:

Science and the Public

Theoretical and practical aspects of the public's role in the development, application, and oversight of scientific and technological advances.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STS 5424

Corequisite(s):

STS 5105:

Contemporary Issues in Science and Technology Studies

Theoretical and methodological issues addressed in the interdisciplinary social study of contemporary science and technology. 5105: social studies of science; 5106: social studies of technology. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5106:

Contemporary Issues in Science and Technology Studies

Theoretical and methodological issues addressed in the interdisciplinary social study of contemporary science and technology. 5105: social studies of science; 5106: social studies of technology. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5205 (HIST 5205):

Main Themes in the History of Science and Technology

Methods and concepts in the history of science and technology. 5205: research methods, interpretive approaches, and contemporary issues in the history of science; 5206: research methods, interpretive approaches, and contemporary issues in the history of technology. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

STS 5206 (HIST 5206):

Main Themes in the History of Science and Technology

Methods and concepts in the history of science and technology. 5205: research methods, interpretive approaches, and contemporary issues in the history of science; 5206: research methods, interpretive approaches, and contemporary issues in the history of technology. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5305 (PHIL 5305):

Main Themes in the Philosophy of Modern Science and Technology

Problems, literature, and schools in the philosophy of science and technology. 5305: explanation and confirmation; 5306: theory change. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PHIL 3505

Corequisite(s):

STS 5306 (PHIL 5306):

Main Themes in the Philosophy of Modern Science and Technology

Problems, literature, and schools in the philosophy of science and technology. 5305: explanation and confirmation; 5306: theory change. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STS 5305

Corequisite(s):

STS 5364 (PSCI 5364) (GIA 5364):

Public Ecology

Examines policy developments and practices that move beyond the conceptual divisions and policy operations begun during the 1970s, which largely divided the more natural science-based environmental sciences from social science-based environmental based studies. Mixes the insights of life science, physical science, social science, applied humanities, and public policy into a cohesive conceptual and operational approach to environmental protection in the 21st century. Graduate

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5404:

Development of Modern American Science

Development of the sciences and the community of scientists in the American national context. Emphasis on scientific, institutional, and social events from 1830s through 1980s, including the circumstances surrounding the creation of nuclear weapons and the emergence of "big science." An interdisciplinary perspective, exploring traditional and contemporary historiographical and methodological issues and approaches. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5424:

Topics in Science and Technology Studies

Variable topics in science and technology studies such as role of values in science and technology, risk assessment, and past and present relations of religion to science and technology. May be repeated to a maximum of 6 hours. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

STS 5444:

Issues in Bioethics

Identification and analysis of ethical issues arising in basic and applied biological, medical, environmental, ecological, and energy studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5514:

Research Designs and Practices for Sts

Examines research designs and practices that uncover historical relationships between knowledge contents and social dimensions of science, technology, and medicine. Includes archival research, archaeology of instruments and physical spaces, interviewing for knowledge content, logical and conceptual analysis, participant observation, questionnaires, and proposal preparation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5584:

Environmental Politics and Policy

Course provides a broad introduction to the key ideas, actors and institutions related to environmental politics and policy in the United States, with some coverage of global issues. It is intended to provide students with basic interdisciplinary knowledge and an intellectual framework for understanding and thinking critically about environmental politics and policy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5614:

Introduction to Science and Technology Policy

Strategies for science and technology policy; science education; scientific and technical information for societal uses; government and public policy; resource allocation; economy and global exchanges of science and technology; approaches to policy evaluation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

STS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

STS 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

STS 6224:

Science, Technology and the Enlightenment

Science, technology, and medicine and their social and cultural interrelationships in the eighteenth and early nineteenth centuries. The modern agenda; nature, knowledge, and progress. Early social science.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6234:

Advanced Topics in the History of Modern Science, Technology and Medicine

Variable topics in history of science, technology, and medicine after 1800, such as the atomic age; space science; science, technology, and institutions; scientific and technological medicine; and environmental history. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6244:

History, Culture, and Politics of the Internet

Explores a variety of social factors, past and present, that have affected the way we make, use, and think about computers and the Internet.

Begins with the origins of the Internet and the people who shape this technology, from military strategists to hackers. Examines the ways diverse groups interact and build communities online and how cultural norms about race and gender shape the ways we participate in the world of computing. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

STS 6314 (PHIL 6314):

History of the Philosophy of Science

Philosophers of science from 1650 to 1900 with particular attention to the historical development of views about the methods of induction and hypothesis and accounts of theory testing. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STS 5305, STS 5306

Corequisite(s):

STS 6334 (PHIL 6334):

Advanced Topics in Philosophy of Science

Variable topics in advanced philosophy of science, including major theories of scientific explanation and their criticisms; philosophical foundations of statistics; naturalized philosophy of science. May be repeated for credit, with permission and different content, for a maximum of 12 hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6524:

Explores diverse traditions of criticism of Western science and technology. Focuses on feminist, Marxist, and ecological perspectives, as well as responses to critics from the scientific community. Prepares students for wider cultural debates about the costs and benefits of science and technology to society.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6534:

Cultural Studies of Science, Technology, and Medicine

Examines the articulation of science, technology, and medicine in diverse cultural contexts. Focuses on exchange of metaphors and forms of discourse with other cultural activities. Includes knowledge forms in popular domains, cultural performances, fashioning of selves, power relations across boundaries, cross-cultural comparisons, and cultural critiques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

STS 6544:

Science, Technology, and Labor

Examines issues of work, skill, and power in science and technology. Considers labor issues from a variety of perspectives, including social constructions of expertise; effects of technical change on the organization of work; industrial automation and "deskilling"; race and gender in divisions of labor; "labor-saving" technology in everyday life; "invisible labor" in information systems; and work practices in the production of science. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

STS 6614:

Advanced Topics in Technology Studies

Variable topics in technology studies, including development and structure of knowledge in technology and engineering, social

construction of technology, knowledge and power in technology, gender and technology, engineering in society, human/nonhuman relations in technology. May be repeated with a different topic for a maximum of 6 credits. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6624:

Advanced Topics in the Life Sciences and Medicine

Variable topics in the life sciences and medicine, such as the reception of Darwinism, conceptual foundations of biology, history of genetics, scientific and technological medicine, public health and epidemiology. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6664 (PAPA 6664):

Advanced Topics in Science and Technology Policy

Variable topics in science and technology policy. Includes advanced study of science, technology, and economy; science, technology, and power; strategies for research and development policy --public and private sector; transfer of technology; technological forecasting; government regulation and responses; science policy assumptions and challenges, specialist knowledge and expertise; state and academic knowledge production; issues of race, class, gender, and national identity in policy work. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6674:

Advanced Topics in Alternate Perspectives On Science, Technology & Medicine

Variable topics in alternate perspectives. Includes science from scientists' perspectives, indigenous knowledge forms, alternative

medicine, New Age science, cyborg theorizing, heterodox perspectives.

May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6834:

Advanced Topics in Social Studies of Science, Technology, and Medicine

Variable topics in social studies of science, technology, and medicine, including studies of disciplines, institutions, boundaries, discourses, knowledges, and practices. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

STS 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

SOCIOLOGY

John Ryan, Chair

Professors: Onwubiko Agozino; David Brunsmas; Toni Calasanti; Theodore Fuller;

Laura Gillman; James Hawdon; Michael Hughes; Wornie Reed; John Ryan; Donald Shoemaker; Barbara Smith;

Associate Professors: Carol Bailey; Samuel Cook; Anthony Harrison; K Kiecolt; Neal King; Anthony Peguero; Paulo Polanah; Paula Seniors; Anastasia Vogt Yuan; Dale Wimberley;

Assistant Professors: Nicholas Copeland; Christine Labuski; Sarah Ovink; Petra Rivera-Rideau; Suchitra Samanta; Haiyan Zhu;

Affiliated Faculty: Karen DePauw; Ellington Graves; Katrina Powell; Karl Precoda; Donna Sedgwick;

General Contact: nmking@vt.edu

Departmental Site: <http://www.sociology.vt.edu/>

The Department of Sociology at Virginia Tech is a premier, research-oriented program, with 29 full-time faculty members and 5 affiliated faculty. Additional sociologists are faculty members in other departments and programs in the University. Our faculty earned degrees from some of the finest doctoral programs in their fields. They have authored or edited over 50 books on such topics as workplace relations, delinquent behavior, drug use, research methods, Appalachian development, deviance, professional ethics, gender, aging, sociology of knowledge, world systems, household crowding, and the mass media. Departmental faculty have published nearly 600 professional articles and chapters, written over 180 technical reports related to applied sociological issues, and participated in more than 75 externally funded projects. In addition, sociology faculty have received numerous college, university, and national awards for outstanding teaching. Our top-flight education and research focus on critical issues in the United States and the increasingly inter-connected world. A solid grounding in theory and methods constitute the core of our graduate programs. Under our broad umbrella of interests having to do with issues of quality of life, inequality, and work and technology, students have the opportunity to specialize in such areas as health, crime/deviance, gender, race, aging, social organization, and culture. In addition, students may choose a specialization in Africana Studies or Women's and Gender Studies. Master's students gain the necessary background for doctoral work or careers in applied settings such as business, federal or state government, and social services. Doctoral students have the opportunity to establish their own programs of study, to engage in their own independent research, to present papers at professional meetings, and to publish. Doctoral students also have the opportunity to gain independent classroom teaching experience.

SPECIAL FACILITIES

Virginia Tech's Department of Sociology is located in McBryde Hall. McBryde Hall houses exceptional teaching classrooms, and the department provides access to computer labs, faculty and graduate student offices, and administration resources

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (153.0), Quantitative (146.0), Analytical (5.0)

The Master's Degree has three options: Master's Degree, Master's Degree Option with Africana Studies, and a Master's Degree Option with Women's and Gender Studies. Master's students must complete 24 hours of coursework, 6 hours of research, and write a thesis. All M.S. students must pass a final exam. Procedures and requirements for the exam are discussed in the Graduate Catalog and the departmental Graduate Handbook. The examination will be a defense of the thesis and an assessment of the student's understanding of appropriate sociological subjects.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (153.0), Quantitative (146.0), Analytical (5.0)

The PhD has three options: PhD in Sociology, PhD in Sociology Africana Studies Option, and the PhD in Sociology Women's and Gender Studies Option. PhD students must complete 60 hours of coursework and 30 hours of research. If the student has a MS or MA degree from another university, up to 24 hours of coursework taken at another university can be transferred in and counted toward the 60-hour requirement. Students are required to have classes in classical and contemporary sociological theory and an advanced theory course. They are also required to have a course in research methods, two graduate-level statistics courses, and an advanced methods or statistics course. Ph.D. Students must also successfully pass a preliminary examination. The examination is to be taken after the student has completed approximately 45 hours of coursework. The preliminary exam is comprehensive in nature and tests a student's ability to integrate, synthesize, and apply sociological concepts in two areas of concentration selected by the student. The exam may also test any aspect of theoretical sociology or research methodology. The student should meet with his or her advisory committee prior to preparing for the exam to discuss the exam and evaluation procedures. The departmental Graduate Handbook discusses these exams in detail.

GRADUATE COURSES (SOC)

SOC 5034:

Social Inequality

Perspectives on the sources and consequences of social inequality.

Comparative analyses of the dynamic social construction of differentiation based on such markers as class, race, ethnicity, gender, age, religion, and sexual orientation, and the opportunities and

constraints for life chances afforded by these processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5104:

History of Sociological Thought

Examination of the social thinkers of the classical period in the development of sociological theory (e.g., Marx, Durkheim, Weber, Ward). Particular attention to the theories, methods, and goals developed by early sociologists.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

SOC 5114:

Contemporary Sociological Theory

Focus on sociological theorists since World War II, including Parsons, Merton, Dahrendorf, Coser, Homans, Blau, Blumer, Kuhn, and Garfinkel.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5204:

Data Analysis

Examination of data analysis designs used in sociology with emphasis on the sociological interpretation of different kinds of analyses; practical applications as used in current research. 3 hours of statistics required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5214 (PAPA 5214):

Research Methods

258 Research methods in sociology including survey methods, qualitative

methods, and experimental design. The link between social theory and social research. Measurement, validity, reliability, and the logic of data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5224:

Intermediate Data Analysis

Application of both common and more advanced quantitative data analytical techniques used in sociology and other social sciences, including multiple regression, regression diagnostics, logistic regression, and causal modeling. Emphasis on analysis and interpretation of sociological survey data using SPSS (Statistical Package for the Social Sciences) and presentation of multivariate analyses to a sociological audience.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5204

Corequisite(s):

SOC 5234:

Sociological Issues in College Pedagogy

Examines economic, political, and public influences on higher education. Explores the implications of inequality in higher education for institutional change and effective pedagogy. Emphasis placed on the scholarship of teaching and learning, including assessment of pedagogical practices for learning-centered classes. Addresses curriculum development in sociology and techniques for overcoming student resistance in sociology classes. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5414:

Crime, Control, and Social Inequality

Dimensions of crime and systems of social control within a framework of social inequality; examines issues of social inequality, such as discrimination, relative to race and ethnicity, social class, and gender, in

crime and systems of social control; international scope.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5444:

Workplace Deviance and Crime

Examination of deviant and criminal behavior in work settings. Stresses and problems in the work system that induce or facilitate deviance and crime. Dimensions of work structure and culture that are conducive to deviance and crime, and the opportunity structures that work systems provide. Emphasis on the theoretical analysis of workplace deviance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5504:

Population Processes and Policies

Historical and comparative studies of population processes (fertility, mortality, migration); contemporary issues related to consequences of population change; population policies designed to modify population trends. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5524:

International Development

Social and cultural factors in the development of societies, including the role of women in development. Contemporary developing countries, and historical material from developed countries; policy issues facing governments of developing countries and those interested in assisting their development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5604:

Organizations in Society

Review of major theories and dimensions of modern organizations, especially technological and managerial arenas influenced by class and power. Labor processes internal to organizations and power networks among organizations. Includes cross-national comparisons.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5614:

Comp Work Systems

Work and occupation in cultural context. Differential organization and perceptions of work in folk, transitional, and industrial societies. The social influence and import of work for individuals.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5624:

Women and Work

The analysis of the economic activities of women in contemporary society. The past and present relationship between women's domestic and market labor is examined, followed by an in-depth investigation of women's labor force experiences. Competing sociological explanations are examined, providing the basis for exploring occupational segregation, inequalities of outcomes and comparable worth.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5654 (GEOG 5654):

The Global Division of Labor

Theory and research on the globalization of the division of labor during the recent past as well as over the past several centuries. Examines the development of the capitalist world-system including the role of

technological forces; the roles of transnational corporations and states in the global economy; the effects of globalization on work and quality of life in the U.S., other developed countries, and the Third World; analyses of globalization in the manufacturing and service sectors; and possible solutions for problems associated with globalization.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5714:

Aging in Social Context

Social, political, and economic environments of aging in a variety of cultures with emphasis on aging problems in American society. Evaluation of the major social theories of aging, their roles in defining problems of the elderly, and focusing on current social policy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5764G:

Advanced International Development Planning and Policy

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

SOC 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

260 Corequisite(s):

SOC 5914:**Orientation to the Discipline**

Orientation for beginning graduate students to the organization of sociology, with emphasis on historical and departmental program areas and to the perspectives and specialties of departmental faculty; systematic and critical review of roles of sociologists, with particular reference to teaching, writing, professional association participation, and professional ethics.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

SOC 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

SOC 6204:**Survey Research Methods**

Survey research techniques used in sociological research including

applied sampling techniques, measurement, scale construction reliability, response effects, administration of survey instruments, data management, and data processing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5204, SOC 5214, STAT 4524

Corequisite(s):

SOC 6214:**Sociological Issues in Qualitative Methodology**

Examines the key components of qualitative methodology with a focus on sociological debates and issues that are contentious, unresolved, and problematic. Explores different methodological perspectives that are vying for prominence within sociology. Particular attention given to the role of gender, class, sexualities, age, race, nationality, ethnicity, disabilities, and colonialism in qualitative methodologies. Conduct qualitative research into the broader critique of the methodology including innovative methodologies being developed by qualitative sociologists.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5214

Corequisite(s):

SOC 6304:**Social Structure and Personality**

Relating social structures and processes to individual personality and behavior. Effects of variables such as social class, religion, race, and gender on social interaction and individual values and attitudes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5304, SOC 5204

Corequisite(s):

SOC 6414:**Theories of Crime and Delinquency**

Examination of major theories of crime and delinquency, with application to specific examples, such as white-collar crime, gender-based patterns of crime and delinquency, and juvenile gangs. Also covers theories and issues concerning the control and prevention of crime and delinquency.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5414

Corequisite(s):

SOC 6504:

The Sociology of Culture

Examination of sociological theory and research on culture, including theories of culture and society; culture as social practice; culture, class and identity; culture and collectivities; culture, power and institutions; the production of culture; cultural reception.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5104 OR SOC 5114

Corequisite(s):

SOC 6524:

Sociology of Health

Examination of sociological theory and research on how social structures and social processes influence the health of individuals and populations. Emphasis on the health consequences of social inequalities by race, class, and gender; the effects of social contexts, networks, and institutions on health; and issues in health care.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SOC 5204, SOC 5214

Corequisite(s):

SOC 6664:

Application of Structural Equations in Education

Applications of structural equation causal models in educational research and discussion of the methodological questions pertaining to such models. Topics include recursive and nonrecursive models, measurement errors in causal models, latent unobserved variables, and covariance structures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): EDRE 6634

Corequisite(s):

SOC 6834:

Advanced Topics in Social Studies of Science, Technology, and Medicine

Variable topics in social studies of science, technology, and medicine, including studies of disciplines, institutions, boundaries, discourses, knowledges, and practices. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 6904:

Proseminar in Sociology

Preparation for successful completion of the Ph.D. and post-doctoral professional roles in the discipline of sociology. Employment sectors for professionals and workforce roles; pedagogical training and techniques in teaching sociology; critical writing skills, identifying publication sources and manuscript preparation requirements; roles in professional associations; proposal preparation and processes for seeking funding for sociological research; ethics in teaching and in research practice. PhD standing in Sociology.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SOC 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

262 Corequisite(s):

THEATRE ARTS

Patricia Raun, Program Director
Susanna Rinehart, Chair

Professors: Ann Kilkelly; Robert Leonard; Patricia Raun; Randolph Ward;

Associate Professors: John Ambrosone; William Barksdale; Patricia Lavender;

Assistant Professors: Joseph Millett; Amanda Nelson; Jane Stein;

General Contact: theatreandcinema@vt.edu

Graduate Contact: rhleonar@vt.edu

Design/Tech Contact: rward@vt.edu

Graduate Site: <http://www.performingarts.vt.edu/study-with-us/theatre-graduate>

Department Site: <http://www.performingarts.vt.edu>

The Theatre and Cinema program, in the School of Performing Arts, is a highly successful and innovative theatre program with a mission to educate and train students in and about theatre and cinema. The program is fully accredited by the National Association of Schools of Theatre, and was the first program in the state to attain that status. The department offers a Master of Fine Arts degree in Theatre Arts, which is designed to train students for professional employment and leadership in the field and providing the terminal degree in the profession. Areas of concentration include Theatre Design and Technology (scenic, lighting, costume, technical direction, sound, visual media, and properties), Directing & Public Dialogue, Arts Administration, and Stage Management. The M.F.A. program focuses on an individualized plan of study for each student, characterized by one-on-one tutorials, realized production work, and close mentoring by faculty artists. This is surrounded by a vision of professional theatre training that is most concerned with the formation of a specific attitude toward the artistic process, a way of thinking based on the changing realities of today's contemporary theatre. It is a vision grounded in collaboration, relevance, and sustainability, favoring knowledge of current affairs and professional practice within an awareness of our sometimes common, sometimes separate, cultural heritages. Each MFA candidate participates in the mounting of productions in the department, working side by side with faculty and staff. The annual production season generally includes four fully mounted main stage shows, 8-12 workshop productions, and two summer shows. In addition, students have frequent opportunities to work on productions outside the department, both on and off campus, locally and beyond. A professional internship also is required for completion of the degree. The program remains small by design, accepting only a few students each year, to allow maximum production opportunities for the MFA student. Every student accepted into the program is awarded an assistantship and full tuition waiver. Our graduates have been exceptionally successful in gaining employment upon completion of the degree. Interested persons are encouraged to visit our web site (www.theatreandcinema.vt.edu) to discover more about us.

SPECIAL FACILITIES

The mission and vision of the theatre production program is to produce new and contemporary plays and new visions of the classics to discover how our performances may connect and stimulate people in the many communities on and off the Virginia Tech campus. We find balance in

the positive value of human connection - the interaction of mind, imagination, and spirit. As such, we believe that theatre is both a community event and a way to build community. Production and teaching facilities are located together on the Blacksburg campus, primarily in Henderson Hall, Theatre 101 - a new LEED-certified facility, and Squires Student Center. Theatre 101 and the renovated Henderson Hall were completed in the fall of 2009.

Classrooms and Labs

The newly renovated Henderson Hall houses general and dedicated classrooms, faculty offices, and fully equipped specialty labs, including: a CAD computer lab with multiple stations, a lighting design lab, a model-building lab, and an A/V sound and visual media design lab. Graduate student offices also are in this building.

Performance Venues

The Studio Theatre is a 214-seat three quarter thrust/modified proscenium designed by Theatre Arts faculty member Randy Ward. It features state-of-the-art lighting, sound, and video systems, with a trap below and flexible actor access surrounding the stage area. A dismantlable second level gallery is a readily available addition to the performance space. Its location directly in front of the Scene Shop makes set construction and loading remarkably convenient. The Haymarket Theatre in Squires Student Center is a 485-seat George Izenour designed traditional proscenium with continental seating and a 34-foot wide proscenium, lending to more traditional theatre works. It is fully equipped with sound, lighting, and fly systems. Theatre 101 is a new teaching theatre space and classroom facility that opened in Fall 2009. It is a 42 x 42 square foot open space with a lighting grid at 18 feet above stage level. Audience risers and portable seating allow flexible staging configurations; a box office and dressing room add further support. This venue is used primarily for workshop productions directed by students and faculty and for occasional guest productions. The new facility has strong technical capability and a lobby front offering a public face to the campus and the town of Blacksburg.

Production Support Facilities

The department maintains a fully equipped Scene Shop and Costume Shop for the construction of sets and costumes. The Scene Shop is a 3500 square foot space with 20 feet of clear height and an accessible loading dock, located immediately adjacent to The Studio Theatre. The Costume Shop is a 1200 square foot space featuring excellent resources for cutting, patterning, construction and finishing, fittings, and storage necessary for complete design and build of costumes and costume crafts.

DEGREES OFFERED

MFA Degree

Offered In (Blacksburg)

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Completion of the MFA degree in Theatre Arts requires: - A three-year program of study- A minimum 54 hours graduate credit- A required professional internship for one semester, usually in the third year, with a successful evaluation- A Final Project and Report, or sanctioned alternative (including a thesis option)The core of the curriculum lies in the Studio format, one-on-one tutorials with the student's primary advisor. The educational value of the studio experience is based on regularly planned projects designed as experiential labs. The primary advisor mentors the artistic progress of the student through these projects and guides the development of the student's overarching goals and curricular needs. Each student participates in a required review with graduate committee members at the end of each semester of enrollment to evaluate work done, assess progress, and plan future projects and experiences. A unique Plan of Study, designed to the needs of each student, is developed to track progress toward the degree.

GRADUATE COURSES (TA)

TA 5015:

Graduate Seminar

Special topics in the theory and practice of theatre, current trends, and recent developments. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5016:

Graduate Seminar

Special topics in the theory and practice of theatre, current trends, and recent developments. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5315:

Advanced Directing

Script analysis, theories, techniques, and practical applications of theatrical direction.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5315G:

Advanced Directing

Script analysis, theories, techniques, and practical applications of theatrical direction. Theories and aesthetics of directing, functions of the director, script analysis, basic principles and techniques of staging. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5316G:

Advanced Directing

Script analysis, theories, techniques, and practical applications of theatrical direction. Rehearsal techniques, style determination realism, and non-realism.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): TA 5315G

Corequisite(s):

TA 5415:

Production Studio I

Investigation of various fundamental production problems involving topic-oriented research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5416:

Production Studio I

Investigation of various fundamental production problems involving

264 topic-oriented research, collaborative work, and individual projects. (2H,

2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5425:

Production Studio II

Investigation and experimentation with various advanced production problems involving topic-oriented research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5426:

Production Studio II

Investigation and experimentation with various advanced production problems involving topic-oriented research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5435:

Production Studio III

Investigation of specific production problems requiring the application of professional competencies (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5436:

Production Studio III

Investigation of specific production problems requiring the application of

professional competencies. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5615:

Arts Management Studio I

Topic-oriented investigation of various fundamental arts management problems involving research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5616:

Arts Management Studio I

Topic-oriented investigation of various fundamental arts management problems involving research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5625:

Arts Management Studio II

Topic-oriented investigation and experimentation with various advanced arts management problems involving research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5626:

Arts Management Studio II

Topic-oriented investigation and experimentation with various advanced arts management problems involving research, collaborative work, and individual projects. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5635:

Arts Management Studio III

Topic/project-oriented investigation of specific arts management problems requiring the application of professional competencies. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5636:

Arts Management Studio III

Topic/project-oriented investigation of specific arts management problems requiring the application of professional competencies. (2H, 2C minimum; 6H, 6C maximum) each. I,II

Credit Hour(s): 2 TO 6

Lecture Hour(s): 2 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5704:

Graduate Theatre Internship

Internship of one semester in production (technical theatre, design, or directing), child drama (theatre for youth or creative drama), or arts management (including stage management) with a professional theatre company or similar off-campus professional situation. I,II,III,IV

Credit Hour(s): 9

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s):

Corequisite(s):

TA 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

TA 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

TA 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

TA 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

AEROSPACE ENGINEERING

Eric Paterson, Head

Professors: Alan Brown; Robert Canfield; William Devenport; Rakesh Kapania; Eric Paterson; Pradeep Raj; Christopher Roy; Joseph Schetz; Robert Walters; Craig Woolsey;

Associate Professors: Jonathan Black; Mazen Farhood; Lin Ma; Leigh McCue-Weil; Wayne Neu; Mayuresh Patil; Michael Philen; Cornel Sultan;

Assistant Professors: Colin Adams; Seongim Choi; Kevin Lowe; Gary Seidel; Bhuvana Srinivasan; Kevin Wang; Heng Xiao;

NAVSEA Professor of Naval Ship Design: Alan Brown;

Norris and Laura Mitchell Professor of Aerospace Engineering: Rakesh Kapania;

Rolls-Royce Commonwealth Professor of Marine Propulsion: Eric Paterson;

Fred D. Durham Endowed Chair Professor: Joseph Schetz;

Graduate Contact: aoegradcoordinator@vt.edu

Student Handbook: http://www.aoe.vt.edu/graduate/forms/AOE_Graduate_PP_Fall-2011.pdf

Graduate Site: <http://www.aoe.vt.edu/graduate/index.html>

Master of Science Degree The Department of Aerospace and Ocean Engineering offers a Master of Science Degree in Aerospace Engineering and in Ocean Engineering. Each of these degrees has two options, a Master of Science with or without thesis. Although both degrees require the same number of credit hours for graduation, the thesis option requires some of these credits be devoted to a research project. The non-thesis option can be obtained by taking only course work, or it can include credits for a project and report. Such a project and report is generally not research oriented, but deals with other aspects of an engineering problem and may involve a team of students. In order to ensure that all our students can communicate with scientists and engineers outside their primary field of interest, all students take at least one course in the general areas of aerodynamics, structures, flight mechanics and control, and numerical methods. In addition, students in the non-thesis program are required to take additional courses in their area of study. Students in this program have the opportunity to work on advanced research projects in the three areas mentioned previously as well as in the interdisciplinary arena where familiarity with two or more disciplines is required. As a result many of our students are in a position to satisfy the rapidly growing demand for well rounded engineers and scientists. In addition, the Aerospace and Ocean Engineering Department participates in the Systems Engineering interdisciplinary program where students take courses across several engineering departments and outside of the College of Engineering. The requirements for this program are set by the Systems Engineering Advisory Committee and are different from those indicated previously. Students following the thesis route work with faculty that have both national and international reputations in their respective areas of research. These areas pose exciting new challenges to the students who have the opportunity to work closely with their faculty advisor on current problems. These problems reflect the latest interests in new advancements in science and technology by NASA, Navy, Air Force, and various aerospace and non-aerospace industries. Our masters students do significant hands-on research and often work in teams with

other masters and Ph.D. students on wide-range of topics, some focused in a newly developing area, and some multidisciplinary in nature. These activities include state-of-the art research in aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Students are encouraged to present their research results at conferences and in archival journals tied to industry and/or government or sponsored projects and include interaction with personnel and facilities from those organizations. The requirements for the degrees focused on applied physics or applied mathematics are slightly different from those of the other categories in that some required courses from the Aerospace and Ocean Engineering Department are replaced with others from either Physics or Mathematics respectively. These programs are specially tailored for students whose backgrounds are from outside the engineering environment and are interested in applying their skills to solving aerospace problems. Such programs encourage interaction with disciplines outside the usual engineering environment and result in new approaches to analyzing and solving problems. Master of Engineering Degree The Aerospace and Ocean Engineering Department offers a Master of Engineering degree in Aerospace Engineering. This degree requires the completion of a project and report which in some cases is required to be in conjunction with other students. For the Aerospace Engineering Degree, students are required to take at least one course in each general area of aerodynamics, structures, and flight mechanics and control. This requirement is to insure that graduates from this program can operate in a multidisciplinary environment. In all cases the Master of Engineering program focuses on engineering type problems and their solutions. Doctor of Philosophy Degree The Aerospace and Ocean Engineering Department offers a Doctor of Philosophy Degree in Aerospace Engineering. This degree is a research oriented degree which can be focused toward one (or more) of several disciplines. These disciplines include aerodynamics, structures and structural dynamics, flight dynamics and control, ocean engineering, multidisciplinary design, applied mathematics, and applied physics. All of these degrees require an in depth research project which will serve as the subject of the final dissertation. Research projects have been carried out in the areas of computational fluid dynamics (CFD), experimental fluid mechanics (both high and low speed), instrumentation development, composite materials, structural optimization, flutter analysis, nonlinear flight control, pilot-aircraft interactions, aerodynamic modeling, computer aided design, interdisciplinary design and optimization, trajectory analysis and optimization, space mechanics and space vehicle design, to name a few. Many of these programs are tied to industry and/or government sponsored projects and include interaction with personnel and facilities from those organizations. The requirements for the degrees focused on applied physics or applied mathematics are slightly different from those of the other categories in that some required courses from the Aerospace and Ocean Engineering Department are replaced with others from either Physics or Mathematics respectively. These programs are specially tailored for students whose backgrounds are from outside the engineering environment and are interested in applying their skills to solving aerospace problems. Such programs encourage interaction with disciplines outside the usual engineering environment and result in new approaches to analyzing and solving problems. Students in the PhD program work with faculty members known nationally and internationally for their contributions in their research area. Opportunities exist to work on the very latest research projects in the areas of aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Many of these projects are in support of aerospace and non-aerospace industry, NASA, Navy and Air Force initiatives and include both analytical and experimental components. Modern computational and experimental facilities are available to each student including four subsonic wind tunnels and one supersonic wind tunnel. Advanced

instrumentation is available for taking measurements of all type in these facilities.

SPECIAL FACILITIES

Research in Aerospace and Ocean Engineering poses exciting new challenges to the students who have the opportunity to work closely with their faculty advisor on current problems. These problems reflect the latest interests in new advancements in science and technology by NASA, Navy, Air Force, and various aerospace and non-aerospace industries. Our graduate students do significant hands-on research and often work in teams with other graduate students on wide-range of topics, some focused in a newly developing area, and some multidisciplinary in nature. These activities include state-of-the art research in aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Students are encouraged to present their research results at conferences and in archival journals tied to industry and/or government sponsored projects and include interaction with personnel and facilities from those organizations.

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Aerospace Structures and Materials Laboratory (ASML)

The Aerospace Structures and Materials Laboratory (ASML) in the Aerospace and Ocean Engineering department at Virginia Tech is a research and educational facility dedicated to the understanding of structures and materials. The laboratory serves as an instructional center for students who are learning about structures related research at the undergraduate and graduate level. The facility is located in Room 15 of Randolph Hall.

Aerostructures Axial-Torsional Test Facility

This equipment is a large, multi-axial, servo-hydraulic testing machine purchased in 1988 from the MTS Systems Corporation (Eden Prairie, Minnesota), and it is located in 107 Hancock Hall. This machine is capable of simultaneously loading of test articles axially and torsionally, controlling either the axial load or axial displacement and controlling either torque or rotation. The computer automation (MTS TestStar workstation and Model 490 Digital controller) makes it possible to specify random independent biaxial loading on each axis in fatigue, or of a controlled phase relationship between each axis, or to input load spectrums obtained from field measurements, as well as providing data acquisition. The load unit has a fatigue load rating of 110,000 lbs axial and 50,000 lbs-in. torsional. The usable test space is 60 inches vertical spacing between actuator and load cell. Horizontal clearance between

the load frame columns is 30 inches. The maximum stroke of the linear actuator is 6 inches, and the maximum rotation of the rotary actuator is 100 degrees.

Boundary Layer Research Wind Tunnel Laboratory

This research laboratory consists of a low-speed low-turbulence-intensity open-loop pressurized wind tunnel and associated equipment and instrumentation. Downstream of the blower a feedback-controlled rotating-blade damper can produce large-amplitude gusts up to 2 Hz, which is useful for simulating unsteady separating turbulent boundary layers in the test section. The test section is 3 feet wide and 24 feet long, has an adjustable upper wall that permits various streamwise pressure gradients, and has active suction and tangential wall-jet boundary controls on the non-test walls that are used to prevent unwanted stalls in strong adverse-pressure-gradient and unsteady flows. This facility has been used over the past 28 years in a number of experimental studies. Custom-designed and constructed laser-Doppler anemometers have been used. The results have revealed new features of the turbulence structure of turbulent boundary layers and separated flows. Recently Olcmen and Simpson (1995) developed a fiber-optic "5-velocity-component" laser-Doppler velocimeter system for measuring 3 velocity components simultaneously at one point (30 um diameter) and 2 other velocity components at 2 other points. Turbulent convective heat transfer in 3-D and separated flows have also been examined in this facility (Lewis and Simpson, 1996). Currently, this facility and instrumentation are being used to define the second-order turbulence structure of three-dimensional flows around hull/appendage and wing/body junctions.

Dynamic Plunge-Pitch-Roll Apparatus (DyPPiR)

The DyPPiR represents the next generation in wind tunnel testing methodologies: simulation of true unsteady aerodynamics. The DyPPiR is essentially a hydraulically powered, computer controlled, three degree-of-freedom robotic arm that is used to force sting mounted wind tunnel models through general, large excursion, high rate, high Reynolds number maneuvers. The DyPPiR is being used to study the maneuvering performance of submarines and fighter aircraft, and future work will involve even transient racecar aerodynamics. In addition to standard force and moment measurements, surface skin friction measurements (for three-dimensional separation location detection) and surface pressure measurements are made, and a Doppler Global Velocimeter (DGV) will permit 3-component velocity measurements to be made in a plane in the flow at specific instances during a maneuver.

Hypersonic Wind Tunnel

The Virginia Tech blow-down type high-speed wind tunnel which operates at speeds ranging from Mach 2 to 7 is shown in Figures 1 and 2. The blow-down type wind tunnel offers run times on the order of a few seconds at high Mach numbers with relatively steady flow conditions. This facility was obtained through our close and long-term collaborations with the Institute of Theoretical and Applied Mechanics of the Russian

Academy of Sciences in Novosibirsk, Russia. Air (or other working gas) is supplied from a compressor to charge the storage bottles visible within the frame at the bottom. A special fast-acting control valve initiates flow into the plenum chamber. The flow then passes through a contoured, converging-diverging nozzle and out through the diffuser. Due to the working principle of the tunnel and the fast-acting control valve, there is only a slow decrease in total pressure during the run. The variation of the total pressure during the run is in the range of approximately 10%. For Mach numbers above 4, an electric heater raises the total temperature up to 800 K to prevent liquefaction. The nozzle exit diameter is 100 mm. The test cabin arrangement permits the use of relatively large instream models, especially at the higher Mach numbers. This facility can be used for aerodynamic problem investigations which involve proper values of Mach and Reynolds number, to try out new measurement methods in high-speed flows, and for laboratory instruction of students. This laboratory type facility produces a gas flow with good metrology features, which are comparable to the corresponding features of steady flow in modern wind tunnels. -Working gases: air, nitrogen, argon, helium, and other safe gases. The total mass of storage air in 8*40 dm³ bottles with pressure of 150 bars is 56 kg. Each run uses about 2.7 kg/s of pressurized gas. It is possible that standard bottles or a high-pressure compressor with low delivery (capacity) will be used as a working gas supply. The upper limit of stagnation pressure in the storage bottles is $P_b = 15$ MPa. The upper limit of stagnation temperature is $T_o = 800$ K. The minimal values of stagnation pressure P_s and temperature T_s within the test chamber and diffuser are Table No. 1. test section size is 100mm. -Electric heater (220/380 V) with capacity 15 - 20 kW provides the flow stagnation temperature up to 800 K to prevent condensation of air at hypersonic speeds. -Tested models usually have the length 200 - 300 mm at the angle of attack 00 - 100 and 80 - 120 mm at the angle attack up to 400 - 500. The diameter of tested models is 20 - 40 mm. -Inner dimensions of test chamber are 360*226*200 mm. -Run duration depends on the test conditions and is usually from 1.0 to 2.0 s. During this time the flow stagnation pressure and temperature decrease smoothly nevertheless relative flow parameters and Mach number keep their constant values. - Axisymmetric replaceable contoured nozzles are fitted to the flange of a settling chamber.

Low Speed Cascade Wind Tunnel

The Low Speed Compressor Cascade Wind Tunnel was designed to simulate conditions found near the tips of fan blades in high bypass ratio aircraft engines. Coincidentally it is also a fairly good representation of flow near the blade tips of a marine propulsion pump. It is sited in the basement of Randolph hall. The cascade consists 8 cantilevered GE rotor B section blades mounted with an adjustable tip gap. The blades are fabricated from aluminum and have a total chord of 10" and an effective span of 10". The blades are instrumented with mean surface

pressure taps, and a microphone array for unsteady surface pressure measurement. The cascade configuration has a rectangular cross section of 65" by 10". The blade spacing is 9.29", and the stagger angle of the cascade is 56.93 degrees. The inlet angle of the cascade is 65.1 degrees. The centrifugal fan powering the facility produces a free stream velocity of about 25m/s resulting in a chord Reynolds number of close to 400,000. Instrumentation regularly used with the facility includes a two-axis computerized traverse, single and 3-component hot-wire anemometry, a 3-component fiber-optic LDV system, and instrumentation to sense the instantaneous position and speed of the belt. Work is being conducted on this facility by research groups under the direction of Dr. William Devenport and Dr. Roger Simpson. Recent sponsors include the Office of Naval Research and NASA Langley.

Nonlinear Systems Laboratory (NSL)

The Nonlinear Systems Laboratory (NSL) in the Aerospace and Ocean Engineering department at Virginia Tech provides a facility for research and instruction in dynamics and control of nonlinear systems. Founded by Dr. Craig Woolsey and Dr. Naira Hovakimyan in 2005, the NSL is now co-directed by Dr. Cornel Sultan, Dr. Mazen Farhood, and Dr. Woolsey. The NSL is a Core Laboratory in the Virginia Center for Autonomous Systems (VaCAS).

Open Jet Wind Tunnel

The open jet wind tunnel was designed in the Fall of 2008 by members of the Aerospace & Ocean Engineering faculty and constructed in 2009 in the AOE machine shop. This research quality facility main purpose is to serve as an educational tool for undergraduate instruction. The open-jet wind tunnel is a blower type, open circuit facility shown in Figure 1. A steel frame at the base of the facility provides stability while the combination of aluminum composite panels and extruded aluminum frame results in a light weight yet strong structure. The tunnel is powered by a 30hp BC-SW Size 365 Twin City centrifugal fan capable of up to 15m³/s. The fan discharges into a 60, 4m-long diffuser. The flow is then directed into a 1.47m-high by 1.78m-wide settling chamber. A combination of 0.01m-cell size, 0.09m long honeycomb followed by three turbulence reduction screens (made of 0.3mm-diameter fiberglass screen with a 55% open area ratio) ensure a low turbulence and uniform flow. The flow then discharges in the atmosphere through a 5.5:1 contraction nozzle based on a 5th degree polynomial profile. Flow speed is controlled by an AF-600 General Electric variable frequency drive. At a maximum fan speed of 1180 RPM, the flow exits the 5.5:1 contraction at 30m/s. The flow velocity is measured using static pressure taps located at the exit of the settling chamber. A manometer mounted on the side of the tunnel measures the difference between the settling chamber static pressure and the atmospheric. To minimize the impact of the flow on the lab environment, the tunnel is equipped with a jet catcher located 1.2m downstream of the contraction exit (as seen in Figure 2). The main purpose of the jet catcher is to deflect and defuse the stream of air. The

jet catcher is made of an extruded aluminum frame with composite panels. Two fiberglass high-loss screens inside the catcher deflect the flow towards the ground and ceiling. Further high-loss screens located at the top and bottom of the jet catcher reduce the flow velocity before it enters the room. For model mounting, the tunnel is also equipped with an adjustable support frame (shown in Figure 2). The frame is built out of extruded aluminum beams. The various slots on these beams provide great flexibility for positioning models.

Space Systems Simulation Laboratory

The focus of SSSL research is both theoretical and experimental. The lab, located in 214 Hancock Hall, houses the Distributed Spacecraft Attitude Control System Simulator (DSACSS), under development. The purpose of DSACSS is to provide an experimental test bed for the development of distributed control laws, as would be used to control the pointing and spacing of a formation of satellites. Other projects using DSACSS are investigating the behavior of a magnetic bearing on a moving platform, and the use of control moment gyros for attitude control. Finally, several students are working on innovative control schemes for use on HokieSat.

Supersonic Wind Tunnel

The Virginia Tech 23 x 23 cm supersonic/transonic wind tunnel was designed and originally constructed at the NASA Langley Research Center. In 1958, the tunnel was purchased by Virginia Tech and put into operation in 1963. During recent years, several modifications were introduced into the air pumping, tunnel control, and instrumentation equipment which increased the capabilities of the facility. The air pumping system consists of an Ingersoll-Rand Type 4-HHE-4 4-stage reciprocating air compressor driven by a 500 hp, 480V Marathon Electric Co. motor. The compressor can pump the storage system up to 51 atm. A drying and filtering system is provided which includes both drying by cooling and drying by absorption. Air storage system consists of two tanks with a total volume of 23 m. Tunnel control system includes quick opening butterfly valve and a hydraulically actuated pressure regulating 30.5 cm diameter valve. The settling chamber contains a perforated transition cone, several damping screens, and probes measuring stagnation pressure and temperature. The nozzle chamber is interchangeable with two-dimensional contoured nozzle blocks made of steel. The tunnel is equipped with three complete nozzle chambers which presently are fitted with the nozzles for the Mach numbers 2.4, 3.0, and 4.0. The working section of the tunnel is equipped with a remotely controlled model support which allows one to vary the position of a model in the vertical plane. An arrangement for side wall model mounting is also available. An extractable mechanism can be provided for supporting the model during the starting and stopping of the flow. Due to large doors containing the windows in the nozzle and working sections a very good access to the model is ensured. Instrumentation A 30 cm Schlieren apparatus uses two parabolic mirrors and air cooled

high pressure mercury lamp. Shadowgraph pictures can be taken either with a direct-shadowgraph system or with a focused shadowgraph arrangement. A 1 microsecond spark source is used for this purpose. Interferograms may be taken with a laser-based single plate interferometer system and a CCD camera. To record flow phenomena of very rapid action and short time duration, the Hycam high speed motion picture camera can be used. The camera can be optically coupled with either Schlieren or shadowgraph apparatus. Operating speed limits are from 1,000 to 45,000 pictures per second. A six-component force and moment balance is also available. The main pressure measuring system includes a PSI Model 780B electronically scanned pressure system. The system is IBM PC computer controlled and presently can handle 32 pressure inputs (0 to 1 atm) simultaneously but, if a need arises, it can be expanded up to 512 pressure inputs. Pressure data rate is up to 20,000 measurements per second and the accuracy is 0.1% of span. In addition to the electronically scanned pressure system, there are two Scanivalve systems available, each allowing to record up to 48 pressures (0-3 atm) during a run of a few seconds duration. Temperature and heat transfer measurements can be made using an automatic multipoint thermocouple reference system and high-speed potentiometric recorders. Data acquisition is all IBM PC based using modern software such as LabView.

Transonic Cascade Wind Tunnel

The Virginia Tech Transonic Cascade Wind Tunnel is a blow down transonic facility capable of a twenty second run time. An overall layout is given in Figure X, and a photo is shown in Figure Y. The air supply is pressurized by a four-stage Ingersoll-Rand compressor and stored in large outdoor tanks. The maximum tank pressure used for transonic tests is about 1725 kPa (250 psig). A representative test section for gas turbine cascade testing is given in Fig. Y. Test sections for other types of testing such as a steam turbine cascade and compressor cascades have been used in this facility. During a run, the upstream total pressure is held constant by varying the opening of a butterfly valve controlled by a computerized feedback circuit. There is also a safety valve upstream of the control valve to start and stop the tunnel. The test section area is 37.3 cm high, and is designed for blades with an outlet angle of approximately 70 degrees. The blade isentropic exit Mach number is varied by changing the upstream total pressure; the usual range for exit Mach number is 0.7 to 1.35. The throat Reynolds number for typical tests is 340,000. Figure Z is a diagram of the test section. The tunnel mean flow is left to right on the figure, and is turned through 68 degrees by the blade passages, which act as the tunnel throat. Upstream of the blades, the bundle of three shock shapers protrudes from the test section top block; the shocks propagate down from the shaper exit to the bottom of the test section. The high-response total pressure probe for downstream surveys is also shown on the figure, pointing into the cascade exit flow. The probe moves up and down in line with wall static

pressure taps. No tailboard is used downstream of the cascade, which means that a free shear layer forms between the exit plane of the blades and the test section back wall. Note also the upstream total pressure probe, which is fixed at mid-pitch of the Lower passage. Instrumentation A 30 cm Schlieren apparatus uses two parabolic mirrors and air cooled high pressure mercury lamp. Shadowgraph pictures can be taken either with a direct-shadowgraph system or with a focused shadowgraph arrangement. A 1 microsecond spark source is used for this purpose. Interferograms may be taken with a laser-based single plate interferometer system and a CCD camera. To record flow phenomena of very rapid action and short time duration, the Hycam high speed motion picture camera can be used. The camera can be optically coupled with either Schlieren or shadowgraph apparatus. Operating speed limits are from 1,000 to 45,000 pictures per second. A six-component force and moment balance is also available. The main pressure measuring system includes a PSI Model 780B electronically scanned pressure system. The system is IBM PC computer controlled and presently can handle 32 pressure inputs (0 to 1 atm) simultaneously but, if a need arises, it can be expanded up to 512 pressure inputs. Pressure data rate is up to 20,000 measurements per second and the accuracy is 0.1% of span. In addition to the electronically scanned pressure system, there are two Scanivalve systems available, each allowing to record up to 48 pressures (0-3 atm) during a run of a few seconds duration. Temperature and heat transfer measurements can be made using an automatic multipoint thermocouple reference system and high-speed potentiometric recorders. Data acquisition is all IBM PC based using modern software such as LabView.

UAV Airstrip and Hangar Facility

The Kentland Farm UAV Test Facility is located at Virginia Tech's Kentland Farm agricultural research facility, which includes nearly 2,000 acres of university-owned farmland in a sparsely populated area southwest of the main campus. A 70' by 300' permanent asphalt airstrip is located at the center of the farm. The airfield is wired for electricity and is covered by a wireless network with direct internet access. The airfield includes a state-of-the-art weather station to log meteorological data. Construction on a new aerobiology/unmanned systems research and teaching building adjacent to the asphalt airstrip has begun. The building was ready for use December of 2011.

Virginia Tech Stability Wind Tunnel

The Stability Wind Tunnel is operated by the Aerospace and Ocean Engineering Department. With a 1.83m-by-1.83m test-section, it is one of the largest university operated wind tunnels in the United States with maximum speeds of 80m/s (corresponding to a Reynolds number of 5,000,000 per meter). In addition to its size, the flow quality is remarkable making it a prime research facility. The aerodynamic capabilities were recently increased by the addition of a removable anechoic test-section allowing for full-scale aero-acoustic testing. Since

May, 2004, the facility has been under the direction of Dr. William Devenport, and currently employs one full time test engineer and several part time student employees. Detailed information about the Virginia Tech Stability Wind Tunnel can be found in the sections below. You can download the Stability Tunnel brochure for a summary of key features. The Virginia Tech Six Foot Stability Wind Tunnel was originally built at the NACA Langley Aeronautical Laboratory in 1940. It was designed to determine dynamic stability derivatives using a fixed model position, and was known at Langley as the "stability tunnel." Many of the NACA reports containing stability derivative data describe wind tunnel tests conducted in this tunnel. The wind tunnel was acquired by VPI in 1958, and the tunnel was erected in 1959 in a specially designed wing of Randolph Hall. Calibration of the tunnel was carried out from 1959 to 1961, when it became operational again. In 1994 the fan motor was completely overhauled and the windings reinsulated. In 1996 new fan blades were installed increasing the overall tunnel efficiency.

DEGREES OFFERED

MS Degree

Offered In (Virtual, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Master of Science Requirements: Thesis and (Non-Thesis) 1. A minimum of 30 credit hours is required. For thesis students, up to 10 credit hours may be allotted for Research and Thesis (AOE 5994). For non-thesis students, up to 6 credit hours may be allotted for Project and Report (AOE 5904)[1]. 2. A minimum of 12 credit hours (15 for non-thesis) of graded course work numbered 5000 and higher must be included in the Plan of Study. These credit hours do not include the AOE Seminar (AOE 5944), Research and Thesis (AOE 5994) hours, or Project and Report (AOE 5904) hours. 3. A maximum of 6 credit hours (9 for non-thesis) of 5974 and 5984 is allowed. 4. A maximum of 6 credit hours of approved 4000 level course work is allowed. 5. Up to 50% of the courses on the Plan of Study may be transferred from a graduate program at another institution, subject to the approval of the Advisory Committee. Each transferred course must have a grade of B (3.0/4.0) or better. 6. All Aerospace Engineering M.S. candidates are required to take: AOE 5104, Advanced Aero and Hydrodynamics; AOE 5024, Vehicle Structures; AOE 5204, Vehicle Dynamics and Control; and AOE 4404, Applied Numerical Methods. The following additional required courses pertain to the three areas of specialization. Aero-Hydrodynamics: Thesis (non-thesis) students must take 9 (18) credit hours of approved electives. Electives for thesis students are determined in consultation with the Advisory Committee Chair. Non-thesis aero-hydrodynamics students must take two of the following three courses: AOE 5114, High Speed Aerodynamics; AOE 5135, Vehicle Propulsion; or AOE 5144, Boundary Layer Theory and Heat Transfer. Dynamics and Control: Thesis (non-thesis) students must take 9 (18) credit hours of

approved electives. Electives for thesis students are determined in consultation with the Advisory Committee Chair. Non-thesis dynamics and control students must take two of the following three courses: AOE 5774, Nonlinear Systems Theory; AOE 6744, Linear Control Theory[2]; or AOE 5234, Orbital Mechanics. Structures and Structural Dynamics: Thesis (non-thesis) students must take 9 (18) hours of approved electives. Electives for thesis students are determined in consultation with the Advisory Committee Chair. Non-thesis structures and structural dynamics students must take the following two courses: AOE 5034, Mechanical and Structural Vibrations; and MATH 4574, Vector and Complex Analysis for Engineers. 7. All Ocean Engineering M.S. candidates are required to take: AOE 5104, Advanced Aero and Hydrodynamics; AOE 5334, Advanced Ship Dynamics; AOE 4404, Applied Numerical Methods; and AOE 5074, Advanced Ship Structural Analysis[3]. In addition, thesis (non-thesis) students must take 9 (18) hours of approved electives, and non-thesis students must take 6 units of "Project and Report" or complete a 6 unit Capstone Naval Ship Design Project (AOE 5315 and AOE 5316). Electives for thesis students are determined in consultation with the Advisory Committee Chair. Non-thesis ocean engineering students must take two of the following seven courses: AOE 5034, Mechanical and Structural Vibrations; AOE 5044, Dynamic Stability of Structures; AOE 5374, Rationally-Based Design of Ocean Structures; AOE 5144, Boundary Layer Theory and Heat Transfer; AOE 5454, Advanced Aerospace and Ocean Engineering Instrumentation; AOE 4024, An Introduction to the Finite Element Method; AOE 4344, Dynamics of High Speed Marine Craft; AOE 4264, Principles of Naval Engineering; AOE 5314, Naval Ship System Design[4]; and AOE 5434, Introduction to Computational Fluid Dynamics. 8. If a student has previously taken any of the required courses listed above or equivalent, while a Virginia Tech undergraduate or a student elsewhere, that course must be replaced with another course approved by the Advisory Committee. A student will not be allowed to repeat a Virginia Tech course (or an equivalent course from another institution) for a grade. A required AOE course can only be replaced with another AOE course. Master of Science or Master of Engineering Requirements (AOE, Systems Option) The AOE Department, in conjunction with the Systems Engineering Technical Interest Group, offers an interdisciplinary degree in Systems Engineering. The requirements for the degree are essentially the same as those outlined above with the exception of the interdisciplinary aspect of the curriculum, which is prescribed by the Systems Engineering Advisory Board. [1] Non-thesis Ocean Engineering M.S. candidates may take both AOE 5315-5316: Naval Ship Design to meet the 6 unit Capstone Naval Ship Design Project in place of 6 units of AOE 5904: Project and Report. [2] It is strongly recommended that students who wish to take AOE 6744, first take AOE 5744, Linear Systems Theory or an equivalent course on linear, time-varying systems. [3] If AOE 4274: Computer-Based Design of Ocean Structures has already been taken, then one of the following two courses must be substituted: AOE 5024: Vehicle Structures or AOE 5374: Rationally-Based Design of Ocean Structures. [4] It is strongly recommended that students who wish to take AOE 5314: Naval Ship System Design, first take AOE 4264: Principles of Naval Engineering.

MEng Degree

Offered In (Virtual, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Master of Engineering Requirements 1. The M. Eng. degree is a non-thesis degree. However, each candidate is required to prepare a paper, the subject and outline of which must be approved by the student's Advisor and Advisory Committee. The purpose of this paper is to develop and demonstrate the student's ability to plan and carry out projects or problems relating to engineering practice. This project is carried out under the auspices of a special project (AOE 5904: Project and Report). 2. A minimum of 30 credit hours is required, of which 3-6 credit hours must be allotted for AOE 5904. 3. A minimum of 15 credit hours (including 5974 and 5984) of graded course work numbered 5000 and higher must be included in the Plan of Study. 4. A maximum of 6 credit hours of approved 4000 level course work is allowed. 5. A maximum of 9 credit hours of, 5974 and 5984 is allowed. 6. Up to 50% of the courses on the Plan of Study may be transferred and are subject to approval of the Advisory Committee. Each transferred course must have a grade of B (3.0/4.0) or better. 7. A minimum of one approved math course is required. 8. All M. Engr. candidates are required to take: AOE 4404, Applied Numerical Methods; AOE 5104, Advanced Aero and Hydrodynamics; AOE 5024, Vehicle Structures; AOE 5204, Vehicle Dynamics and Control; and One additional AOE course. If a student has previously taken, while an undergraduate or student elsewhere, any of the specific required AOE courses above or equivalent, that course must be replaced with another AOE course acceptable to the Advisory Committee. A student will not be allowed to repeat a course from Virginia Tech or one that is equivalent from another institution for a grade. 9. The project described in requirement (1) may be carried out in conjunction with other students in the same program (e.g., a design project with several students of varied interests). Master of Science or Master of Engineering Requirements (AOE, Systems Option). The AOE Department, in conjunction with the Systems Engineering Technical Interest Group, offers an interdisciplinary degree in Systems Engineering. The requirements for the degree are essentially the same as those outlined above with the exception of the interdisciplinary aspect of the curriculum, which is prescribed by the Systems Engineering Advisory Board.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Doctor of Philosophy Requirements (beyond B.S.) 1. A minimum of 90 credit hours beyond the B.S. degree are required. 2. A minimum of 30 hours of Research and Dissertation (AOE 7994) must be included on the Plan of Study. 3. A minimum of 27 credit hours of graded course work numbered 5000 or above must be included. 4. A maximum of 18 credit hours of Independent Study (5974) and Special Study (5984) may be included. 5. A maximum of 4 credit hours may be seminars (unstructured courses), not including AOE Graduate Seminar (AOE 5944). 6. A minimum of two consecutive semesters of full time enrollment must be spent in residence at the Blacksburg campus (or with prior approval at some designated off-campus graduate center). At least 15 credit hours

of course work (not including AOE 7994) must be earned while in residence. 7. Transfer credit hours may not exceed 50% of graded course work on the Plan of Study and are subject to the approval of the Advisory Committee. 8. All Ph.D. candidates are required to complete selected courses. Some of the courses are required prior to taking the Preliminary Written Examination and the remaining courses are required prior to completion of the degree. The following additional courses are required according to the area of specialization: Aero-Hydrodynamics i. Before taking the Preliminary Written Examination: AOE 4404, Applied Numerical Methods; AOE 5104, Advanced Aero and Hydrodynamics; AOE 5024, Vehicle Structures; AOE 5204, Vehicle Dynamics and Control; AOE 5114, High Speed Aerodynamics; AOE 5135, Vehicle Propulsion; and AOE 5144, Boundary Layer Theory and Heat Transfer. ii. Before taking the Final Examination: AOE 5454, Advanced Aerospace and Ocean Engineering Instrumentation; One of the following courses: AOE 5434, Introduction to Computational Fluid Dynamics; AOE 6145, Computational Fluid Dynamics; or AOE 6434, Computational Fluid Dynamics and Heat Transfer; AOE 6114, Transonic Aerodynamics; and Any two of the following courses: AOE 6124, Hypersonic Aerodynamics; AOE 6154, Turbulent Shear Flow; AOE 6164, Unsteady Fluid Dynamics; AOE 5984, Verification and Validation in Scientific Computing; and AOE 5984, Rarefied Gas Dynamics. Dynamics and Control i. Before taking the Preliminary Written Examination: AOE 4404, Applied Numerical Methods; AOE 5104, Advanced Aero and Hydrodynamics; AOE 5024, Vehicle Structures; AOE 5204, Vehicle Dynamics and Control; AOE 5774, Nonlinear Systems Theory; and AOE 6744, Linear Control Theory[1]. ii. Before taking the Final Examination, courses determined in consultation with the Advisory Committee. Ocean Engineering i. Before taking the Preliminary Written Examination: AOE 4404, Applied Numerical Methods; AOE 5104, Advanced Aero and Hydrodynamics; AOE 5074, Advanced Ship Structural Analysis[2]; and AOE 5334, Advanced Ship Dynamics. ii. Plus any two of the following: AOE 5144, Boundary Layer Theory and Heat Transfer; AOE 4024, An Introduction to the Finite Element Method; ESM 5734, Introduction to Finite Elements; AOE 5034, Mechanical and Structural Vibrations; ESM 5314, Intermediate Dynamics; ECE 5704, Linear Systems Theory; MATH 5425, Applied Partial Differential Equations; MATH 5474, Finite Difference Methods; AOE 5434, Introduction to Computational Fluid Dynamics; or AOE 4344, Dynamics of High Speed Marine Craft. iii. Before taking the Final Examination, take two of the following courses: Courses in group (i) not taken prior to the Preliminary Written Examination; AOE 5044, Dynamic Stability of Structures; AOE 5374, Rationally-Based Design of Ocean Structures; AOE 5454, Advanced Aerospace and Ocean Engineering Instrumentation; AOE 6145, Computational Fluid Mechanics; AOE 5314, Naval Ship System Design[3]; AOE 5064, Structural Optimization; ME 6624, Advanced Finite Element Application; ESM 6314, Advanced Dynamics; or ME 6434, Computational Fluid Dynamics and Heat Transfer. Structures and Structural Dynamics i. Before taking the Preliminary Written Examination: AOE 4404, Applied Numerical Methods; AOE 5104, Advanced Aero and Hydrodynamics; AOE 5024, Vehicle Structures; AOE 5204, Vehicle Dynamics and Control; AOE 4054, Stability of Structures; and AOE 5034, Mechanical and Structural Vibrations. ii. Before taking the Final Examination, any two of the following courses: AOE 5054, Elastic Stability; AOE 5064, Structural Optimization; AOE 5074, Advanced Ship Structural Analysis[4]; or AOE 6024, Aeroelasticity. Applied Physics & Space Engineering i. Before taking the Preliminary Written Examination: AOE 4404, Applied Numerical Methods; AOE 5504, Aerospace and Ocean Engineering; One from ECE 5105, Electromagnetic Waves; ECE 5106, Electromagnetic Waves; or PHYS 5405, Classical Electromagnetism; One graduate level course in Mathematics, as determined by Advisory Committee; One graduate level course in Physics, as determined by Advisory Committee; One graduate

level course in AOE, as determined by Advisory Committee; and One additional graduate level course in AOE, ECE, or Physics, as determined by Advisory Committee. ii. Before taking the Final Examination: Any two from AOE 5024, Vehicle Structures; AOE 5104, Advanced Aero and Hydrodynamics; or AOE 5204, Vehicle Dynamics and Control; and Courses determined in consultation with the Advisory Committee. Applied Mathematics i. Before taking the Preliminary Written Examination: AOE 4404, Applied Numerical Methods; Two from AOE 5024, Vehicle Structures; AOE 5104, Advanced Aero and Hydrodynamics; or AOE 5204, Vehicle Dynamics and Control; MATH 4525, Principles of Advanced Calculus I; MATH 4526, Principles of Advanced Calculus II; and Two additional graduate level Mathematics courses determined in consultation with the Advisory Committee. ii. Before taking the Final Examination: Courses determined in consultation with the Advisory Committee. 9. If a graduate student has previously taken, while an undergraduate or a student elsewhere, any of the required courses listed above or equivalent, that course must be replaced with another course acceptable to the Advisory Committee. A student will not be allowed to repeat a course from Virginia Tech or one that is equivalent from another institution for a grade. 10. Students are required to repeat any courses on the Plan of Study for which a grade of "C-" or below has been earned. Transfer credits must have been earned while in good standing in graduate status, must have been graduate courses (numbered 5000 or higher, or equivalent) at the institution where the courses were taken, and must show a grade of "B" or better. Courses that are double-counted for both an undergraduate and graduate degree for students in Virginia Tech's Undergraduate/Graduate Degree Program are subject to the grade requirements for transfer courses. 11. A person who graduates from this department with a Ph.D. in aerospace engineering is expected to have a broad understanding of the field. The student satisfies this requirement by completing each of the introductory graduate courses in aerodynamics (AOE 5104), dynamics and control (AOE 5204 or AOE 5334), structures (AOE 5024 or AOE 5074), and numerical methods (AOE 4404) with a grade of B or better. That grade will be considered sufficient evidence of knowledge in these areas. Transfer credits for these courses are approved by including them in a properly formulated Plan of Study approved by the student's Advisory committee. For students in the "Applied Physics & Space Engineering" or "Applied Mathematics" track, these requirements apply to the courses above which appear on the Plan of Study. 12. If a student obtains less than a B in the introductory courses listed in Item 3 above, then that student must repeat the course, either formally (grade less than C-) or informally (grade equal or greater than C- and less than a B) and receive a grade of B or better in the course. In the case of an informal retake, the instructor will write a letter to the students file indicating the achievement of a grade of B or better. If this requirement is not completed at the time of the preliminary examination, and the student passes the preliminary examination, the student will be given a conditional pass. Under these circumstances, this requirement must be satisfied within two semesters (i.e. at the first opportunity) after completing the preliminary examination. [1] It is strongly recommended that students who wish to take AOE 6744: Linear Control Theory, first take AOE 5744: Linear Systems Theory or an equivalent course on linear, time-varying systems. [2] If AOE 4274: Computer-Based Design of Ocean Structures has already been taken, then one of the following two courses must be substituted: AOE 5024: Vehicle Structures or AOE 5374: Rationally-Based Design of Ocean Structures. [3] It is strongly recommended that students who wish to take AOE 5314: Naval Ship System Design, first take AOE 4264: Principles of Naval Engineering. [4] If AOE 4274: Computer-Based Design of Ocean Structures has already been taken, then one of the following two courses must be substituted: AOE 5024: Vehicle Structures or AOE 5374: Rationally-Based Design of Ocean Structures.

Corequisite(s):

GRADUATE COURSES (AOE)

AOE 5024:

Vehicle Structures

Exact and approximate methods for analysis and design of aerospace and marine structures. Stresses, strains, constitutive equations, boundary value problems, and two-dimensional elasticity; torsion; variational methods; virtual work and energy principles; structural mechanics theorems; traditional approximate methods; and laminated plates.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5034 (ESM 5304):

Mechanical and Structural Vibrations

Free and forced vibrations of single-degree-of-freedom systems, multi-degree-of-freedom systems, continuous systems including strings, rods, bars, and beams. Natural frequencies and modes. Rigid Body modes. Proportional and nonproportional damping. Response to harmonic, periodic, and nonperiodic excitations. Solutions by modal analysis, direct integration and Fourier Series. Approximate methods including assumed modes and the Rayleigh-Ritz method. Advanced topics chosen by instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5024

Corequisite(s):

AOE 5044:

Dynamic Stability of Structures

Modern structural stability analysis; static and dynamic instability; conservative and nonconservative systems; multiple loads; and Liapunov stability analysis. Applications to columns, rotating shafts, pipes conveying fluid, and airplane panels. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4074 (UG) OR AOE 3034 (UG)

AOE 5054 (ESM 5454):

Elastic Stability

Stability of elastic structural components under conservative loads; precise definitions of stability; energy approaches; Rayleigh-Ritz and Galerkin methods; and applications to column, arches, plates, and shells. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3124 (UG) OR CEE 3404 (UG)

Corequisite(s):

AOE 5064:

Structural Optimization

Structural optimization via calculus of variations. Application of techniques of mathematical programming to optimize trusses, beams, frames, columns, and other structures. Sensitivity calculation of structural response. Approximation techniques and dual and optimality criteria methods. A background in optimization is necessary. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5074:

Advanced Ship Structural Analysis

Computer modeling of ship structures. Levels and types of structural failures in ships. Elastic and inelastic plate bending. Elastic and inelastic buckling of columns, plates and stiffened panels. Computer programs for ultimate strength analysis of ships. Sample applications. Pre: Graduate standing in Engineering.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5024

Corequisite(s):

AOE 5084:

Submarine Design

Application of engineering disciplines to the design of a steam turbine propelled nuclear submarine. The disciplines involved are fluid

mechanics, solid state mechanics, structures, machine design, thermodynamics and heat transfer.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5104:

Advanced Aero and Hydrodynamics

Vector analysis concepts; fluid stress and strain, kinematics of fluid flows including vorticity; dynamics of inviscid incompressible flow; and potential flow theory with applications to lifting and non-lifting bodies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5114:

High Speed Aerodynamics

Aerothermodynamic phenomena and shock waves. Linearized subsonic and supersonic flow past planar surfaces and bodies of revolution. Theory of transonic aerodynamics including study of mixed flow. Similarity laws. Mathematical representation of inviscid compressible flows in equilibrium. Potential function, stream function, rotationality and geometrical considerations. Method of characteristics applied to hyperbolic flow fields. Discussion of techniques for solution of elliptic flow fields.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG)

Corequisite(s):

AOE 5135 (ME 5135):

Vehicle Propulsion

Aerothermodynamics of gas turbines and rockets: cycle analysis of turbojets, turbofans, prop fans, and turbo props. Analysis of ramjets and scramjets. Performance of inlets, combustors, and nozzles. Elementary theory of turbomachinery. Liquid and solid propellant chemical rockets. Electrostatic, electromagnetic, and electrothermal propulsion. Integrated rocket-ramjet. Fuels and propulsion systems for future transportation system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG), ME 3134 (UG)

Corequisite(s):

AOE 5136:

Vehicle Propulsion

Aerothermodynamics of gas turbines and rockets: cycle analysis of turbojets, turbofans, prop fans, and turbo props. Analysis of ramjets and scramjets. Performance of inlets, combustors, and nozzles. Elementary theory of turbomachinery. Liquid and solid propellant chemical rockets. Electrostatic, electromagnetic, and electrothermal propulsion. Integrated rocket-ramjet. Fuels and propulsion systems for future transportation system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3114 (UG), ME 3134 (UG)

Corequisite(s):

AOE 5144:

Boundary Layer Theory and Heat Transfer

Conservation equations and constitutive relations, exact Navier Stokes solutions; boundary layer approximation and special solutions; approximate methods; compressibility and heat and mass transfer effects; and numerical methods and simple turbulence models.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5104 (UG)

Corequisite(s):

AOE 5204:

Vehicle Dynamics and Control

Relevant rigid body kinematics and dynamics fundamentals for vehicles such as aircraft, spacecraft, and ships. Provides foundation for advanced courses and research on dynamics and control of vehicles. Review of particle motion and application to aircraft performance and satellite orbital mechanics. Rigorous modeling of rotational and translational motion of rigid bodies. Linearization of equations of motion for stability analysis, modal analysis, control system synthesis, with introduction to classical control system concepts. Sensors and actuators commonly used on vehicles. Specific examples from aircraft, missiles, spacecraft,

rockets, ships, and submersibles.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3134 (UG), AOE 3234 (UG) OR AOE 4140 (UG)

Corequisite(s):

AOE 5214:

Aircraft Dynamics and Control

General equations of aero/hydrodynamic vehicular motion including the effects of flexibility and changing mass. Consideration of buoyant, aerodynamic, gravitational and thrust forces, jet damping, thrust offset, and rotating machinery contributions. Reduction of equations to linearized form, aero/hydrodynamic stability derivatives. Stability and response characteristics. Application of classical control theory to aircraft control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3134 (UG)

Corequisite(s):

AOE 5234:

Orbital Mechanics

Lagrange's equations of motion, two-body problem, conic sections, Kepler's laws, orbit determination. Multi-body problems and integrals of motion. Fundamentals of perturbation theory, variation of parameters, and Lagrange's planetary equations. Regularization and alternative formulations of equations of motion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 4134 (UG)

Corequisite(s):

AOE 5244:

Optimization Techniques

Ordinary minimum problems with constraints. The classical multiplier method, descent methods, and quasi-Newton methods. Optimal control and the maximum principle. Second-order necessary conditions.

Singular control. Continuous gradient methods, conjugate gradients.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3134 (UG), MATH 4564 (UG)

Corequisite(s):

AOE 5304:

Advanced Naval Architecture

Engineering analysis methods for evaluating the hydrostatic, hydrodynamic, and structural characteristics of surface ships and submarines. Methods employed in ship design include analytical, statistical, and experimental approaches. Both hull and propulsor analysis techniques are covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5305:

Marine Engineering

In depth analysis and design of major ship propulsion system and machinery components. 5305: Propellers, shafting and gearing. Intro. to boilers, steam and gas turbines, nuclear power plants and diesels. 5306: Advanced study of diesels and gas turbines. Internal combustion engines. Shipboard HVAC, pump and motor systems. Cost estimation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ME 3134 (UG)

Corequisite(s):

AOE 5306:

Marine Engineering

In depth analysis and design of major ship propulsion system and machinery components. 5305: Propellers, shafting and gearing. Intro. to boilers, steam and gas turbines, nuclear power plants and diesels. 5306: Advanced study of diesels and gas turbines. Internal combustion engines. Shipboard HVAC, pump and motor systems. Cost estimation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3134 (UG)

Corequisite(s):

Naval Ship System Design and Effectiveness

Concepts, theory, and methods for the engineering, design, integration, and assessment of naval ship systems. Modeling of system effectiveness for multidisciplinary and multi-objective design optimization. Mathematical theory for naval effectiveness models (OEMs) and physics-based mechanical, electrical, sensor, control, and weapon systems models to assess total-ship effectiveness in anti-air warfare, target coverage, and fleet air warfare. System integration, interfaces, and analyses considering ship arrangements, electromagnetic compatibility, signatures, system deactivation diagrams, reliability, maintenance, modularity, system power, shock and weapons effects, fire analysis, damage control, and overall system survivability.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5304, AOE 5405

Corequisite(s):

AOE 5315:

Naval Ship Design

Capstone naval ship design concept exploration including the study and application of the system engineering process to the simultaneous development of naval ship requirements, selection of ship technologies, and definition of a baseline naval ship design. Hullform, machinery, ship synthesis and balance, metrics (including Overall Measure of Effectiveness, technology risk, and cost) and design optimization in the context of a naval ship design project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5304, AOE 5305, AOE 5314, AOE 5334, AOE 5074

Corequisite(s):

AOE 5316:

Naval Ship Design

Development of a naval ship baseline design including hullform, combat systems, topside arrangements, internal subdivision and tankage, power and propulsion, auxiliary machinery, general arrangements, machinery arrangements, human systems, structural design, assessments of intact and damage stability, shock and survivability, weights, space, seakeeping, cost, risk, and overall balance and feasibility.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5315 (UG)

Corequisite(s):

AOE 5334:

Advanced Ship Dynamics

Derivation of the equations of motion of a ship; waves and wave forces on structures; description of wave statistics and spectral representation in a given sea state; ship response in regular waves; ship response in random waves.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3234 (UG), MATH 4564 (UG)

Corequisite(s):

AOE 5344:

Nonlinear Control of Mechanical Systems

Methods of nonlinear control, emphasizing techniques applicable to mechanical systems. Nonlinear system theory and stability analysis. Nonlinear controllability and observability. Input-output properties. Passive and dissipative systems and stability of interconnected systems. Common nonlinear control design techniques: feedback linearization; sliding mode control; adaptive control. Techniques for mechanical systems: potential shaping; kinetic shaping. Emphasis on applications to vehicle control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 4004 (UG)

Corequisite(s):

AOE 5374:

Rationally-Based Design of Ocean Structures

Methodology of rationally-based optimum structural design of ships based on explicit calculation of failure loads. Torsion of thin-wall sections. Ultimate limit states of stiffened cylinders. Structural optimization of stiffened panels. Computer programs for ultimate strength analysis and structural design of ships, submarines and offshore platforms. Sample applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5074 (UG)

Corequisite(s):

AOE 5434G:

Advanced Introduction to Computational Fluid Dynamics

Euler and Navier-Stokes equations governing the flow of gas 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. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5444G:

Adv Dyn of High-Speed Craft

Study of the dynamics of high-speed craft, including surface effects ships, hydrofoil vessels, semi-displacement monohulls and catamarans, and planning vessels. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5454:

Advanced Aerospace and Ocean Engineering Instrumentation

An advanced treatment of the principles of measurement systems; standards, accuracy, uncertainty and statistical concepts, and signal processing. Detectors, transducers, and instruments for aerospace and ocean engineering. Hot-wire and laser anemometry. Signal conditioning systems and readout devices, digital data acquisition principles.

Electronics and electrical test instruments. Case studies of practical instrumentation systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3014 (UG), AOE 3034 (UG)

Corequisite(s):

AOE 5504:

Aerospace and Ocean Engineering

Introduction of the natural space environments: solar wind, planet atmosphere, ionosphere, magnetosphere, comets, and meteoroids.

Introduction of the induced spacecraft environments. Advanced treatment of the physics and effects of atmospheric interactions, plasma interactions, radiation interactions, hypervelocity impacts, spacecraft contamination, and interactions induced by electric propulsion. Applications to spacecraft design. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 4174 (UG), AOE 4404 (UG)

Corequisite(s):

AOE 5734 (ECE 5734) (ME 5584):

Convex Optimization

Recognizing and solving convex optimization problems. Convex sets, functions, and optimization problems. Least-squares, linear, and quadratic optimization. Geometric and semidefinite programming. Vector optimization. Duality theory. Convex relaxations. Approximation, fitting, and statistical estimation. Geometric problems. Control and trajectory planning. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5744 (ME 5544) (ECE 5744):

Linear Systems Theory

Advanced introduction to the theory of time-varying and time-invariant linear systems represented by state equations; solutions of linear systems, uniform stability and other stability criteria, uniform observability and controllability, state feedback and observers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4634 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

AOE 5754 (ECE 5754) (ME 5554):

Applied Linear Systems

278 Develop an applied understanding of state-space representations for

linear time invariant multi-input multi-output dynamic systems in both time domain and frequency domain. Introduction to modern state-space control methods; state feedback and output feedback. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

AOE 5764 (ME 5564) (ECE 5764):

Applied Linear Control

Analysis and design of sampled-data systems, extraction of discrete-time dynamic models from experimental data, and implementation of dynamic compensators on digital processors. In-depth design experience with LQR optimal control and an introduction to Kalman filtering. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5744 OR AOE 5754 OR ME 5554 OR ME 5544 OR ECE 5744 OR ECE 5754

Corequisite(s):

AOE 5774 (ECE 5774) (ME 5574):

Nonlinear Systems Theory

Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations: existence and uniqueness of solutions; continuous dependence on parameters; stability of equilibria and stability analysis techniques; input-to-state stability; input-output stability; nonlinear design techniques including input-state and input-output feedback linearization, backstepping, and sliding mode control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

AOE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

AOE 5914:

Autonomous Systems Seminar

Weekly technical presentations from local and visiting scholars on current topics related to the theory, design and development, and application of autonomous vehicle systems. Pre-Requisite: Graduate Standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5944:

Seminar

Discussion of current research topics in Aerospace and Ocean Engineering by local and visiting scholars. This course cannot be used to fulfill the minimum requirements of 30 hours toward the Master's Degree or 90 hours toward the Ph.D. Degree in Aerospace and Ocean Engineering. May be repeated.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5974:

Independent Study

279 Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

AOE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

AOE 6024:

Aeroelasticity

Discussion of the aeroelastic phenomena including flutter, divergence, control surface effectiveness, and lift redistribution; and introduction to traditional and modern methods of analysis and remedies for aeroelastic problems of flight vehicles.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5034, AOE 5104, AOE 5214

Corequisite(s):

AOE 6114:

Transonic Aerodynamics

Basic features of transonic flows, similarity methods, and hodograph methods. Major emphasis on finite difference procedures including type dependent relaxation procedures for potential flows and time asymptotic Euler solutions. Grid generation methods, inverse design procedures, unsteady flow, wind tunnel/wall interference, and shock wave/boundary layer interactions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG), AOE 4404 (UG), AOE 5144 (UG)

Corequisite(s):

AOE 6124:

Hypersonic Aerodynamics

Theory of inviscid hypersonic flows; blunt body and Newtonian aerodynamics; nonlinear small disturbance theory; and approximate methods and comparisons with experiment. Viscous hypersonic flow theory; skin friction and heat transfer on blunt and slender bodies; and vorticity, entropy layer, and viscous-inviscid inter-action effects.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5114 (UG)

Corequisite(s):

AOE 6145:

Computational Fluid Dynamics

Computational methods for incompressible, compressible, and viscous fluid flows. Theoretical and numerical developments for wave equation, heat equation, Poissons equation, and Burgers equation. Applications to inviscid subsonic, transonic, and supersonic flows, viscous boundary layer, Navier Stokes, thin layer equations, and grid generation techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG), AOE 4404 (UG), AOE 5104 (UG)

Corequisite(s):

AOE 6154:

Turbulent Shear Flow

Advanced treatment of the physical phenomena of turbulent boundary layers, jets, wakes, and duct flows; coherent structures; entrainment, bursting, vortex dynamics; and unsteady, wall, and freestream turbulence effects.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5144 (UG)

Corequisite(s):

AOE 6204:**Adv Vehicle Dynamics & Control**

Topics in the dynamics and control of systems including airplanes, helicopters, spacecraft, and structures. Physics and data-based modeling from the control system designer's perspective. Structure of the control-oriented equations of motion in relation to robust control design. Bio-inspired design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5024, AOE 5204

Corequisite(s):

AOE 6234:**Spacecraft Dynamics and Control**

Rigid body kinematics and spacecraft attitude descriptions. Attitude dynamics, motion about the center of mass, gravity gradient, and stability. Methods of attitude control both active (momentum exchange devices, thrusting) and passive (spin stabilization). Small and large angle feedback control laws. Attitude maneuvers of hybrid bodies containing both rigid and flexible components. Pre: AOE 5204, or permission of instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 4134 (UG), AOE 5234 (UG)

Corequisite(s):

AOE 6254:**Intelligent Control**

Intelligent control design of nonlinear systems, autonomous vehicles, including unmanned aerial vehicles, autonomous underwater vehicles, and spacecraft. Review of methods for stability analysis and robust control. Adaptive control design methodologies. Robustness of adaptive systems. Vision based sensors. Multivariable adaptive control. Output feedback methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5344 (UG) OR ECE 6414 (UG)

Corequisite(s):

AOE 6434 (ME 6434):**Computational Fluid Dynamics and Heat Transfer**

Overview of numerical methods used in the study of computational fluid dynamics (CFD) and heat transfer. Spatio-temporal finite-difference, finite-volume discretizations, solution of linear systems with direct and iterative methods, algorithms for solving the Navier Stokes and energy equations, and turbulence modeling. Applications to inviscid subsonic, transonic, and supersonic flows and viscous boundary layer. Theory reinforced with hands on programming assignments and the application of commercial CFD packages to select problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5404, ME 5314, (AOE 3114 (UG) OR AOE 3114), (ME 4404 (UG) OR ME 4404), ME 5104

Corequisite(s):

AOE 6444 (CS 6444) (ME 6444):**Verification and Validation in Scientific Computing**

Applicable to scientific and engineering models described by partial differential or integral equations. Software engineering, code verification, and the method of manufactured solutions for generating exact solutions. Estimation of numerical approximation errors in scientific computing. Design and execution of experiments for model validation and model accuracy assessment. Propagation of aleatory and epistemic uncertainty through models. Estimation of total prediction uncertainty in scientific computing simulations. Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 6744 (ECE 6744) (ME 6544):**Linear Control Theory**

Advanced introduction to the theory of optimal control of time-varying and time-invariant linear systems; Solutions to the linear-quadratic regulator, optimal filtering, and linear-quadratic-gaussian problems; Robustness analysis and techniques to enhance robustness of controllers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5544 OR ME 5554 OR AOE 5744 OR AOE 5754

Corequisite(s):

AOE 6774 (ECE 6774) (ME 6574):

Adaptive Control Systems

Introduction to the theory and methodology used to design adaptive controllers for uncertain systems, addressing issues such as input constraints, disturbance rejection, partial measurements, and robustness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 5774, ECE 5744) OR (ME 5544, ME 5574) OR (AOE 5774, AOE 5744)

Corequisite(s):

AOE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

BIOLOGICAL SYSTEMS ENGINEERING

Mary Leigh Wolfe, Head

Emeriti Faculty: John Cundiff; John Perumpral;

Professors: Theo Dillaha; Robert Grisso; William Hession; Saied Mostaghimi;

Mary Leigh Wolfe; Chenming Zhang;

Associate Professors: Justin Barone; Brian Benham; Conrad Heatwole;

Parameswaran Mallikarjunan; Jactone Ogejo; Theresa Thompson; Yi Heng Zhang;

Assistant Professors: Matteo Convertino; Zachary Easton; Leigh Anne Krometis;

Warren Ruder; David Sample; Durelle Scott; Ryan Senger;

Research Faculty: Karen Kline; Eugene Yagow; Chun You; Xing Zhang; Hong Zheng;

General Contact: bseacademics@vt.edu

Graduate Site: <http://www.bse.vt.edu/graduate/index.html>

The mission of the Biological Systems Engineering Department is to develop and disseminate engineering knowledge and practices that protect natural resources and improve sustainable production, processing, and utilization of biological materials. This mission is achieved through strong teaching, research, and extension programs focused in two broad areas: Biomolecular Engineering; and Watershed Science and Engineering. The Biomolecular Engineering area focuses on the design and development of processes for environmentally responsible manufacturing of food and industrial products from biological materials. Areas of interest include: Bioenergy Bioresidue management and utilization Food safety and engineering Metabolic Engineering Protein/enzyme processing and engineering Nanotechnology Renewable materials Synthetic biology The Watershed Science and Engineering area focuses on environmental protection and natural resources management. Areas of interest include: Ecological hydrology Ecological engineering Environmental health Hydrologic and water quality modeling Nonpoint source pollution control Storm water management and low impact development Stream and wetland restoration Watershed management

SPECIAL FACILITIES

Information about the following facilities is available on our web site:

Facilities

Biofuels Laboratory Bioresource Management and Utilization Engineering Laboratory Ecological Engineering Laboratory Fluvial Processes Laboratory Food Process Engineering Laboratory Hydroecology Laboratory Metabolic Engineering Laboratory Nanotechnology Laboratory Prices Fork Research Facility Protein Separation Laboratory Renewable Materials Laboratory StREAM Lab Synthetic Biology and Integrated Systems Engineering Laboratory Water Analysis Laboratory Watershed Monitoring Laboratory Watershed Systems Analysis Laboratory Watershed Assessment Laboratory Center for Watershed Studies

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Master of Science - Thesis (MS) The Department offers the MS degree

with a thesis option. For a thesis option, the student in the MS program will conduct independent research and will produce a thesis and defend the research findings for fulfilling the requirements of the degree. A minimum of 30 total credits (24 course credits) are required. Master of Science - Non-thesis (MS) The Department offers the MS degree, non-thesis option as well. For a non-thesis option, the student will be involved in completing a focused research/design activity and submit a research report and make an oral presentation detailing the research findings. A minimum of 30 total credits (24 course credits) are required.

MEng Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Master of Engineering (ME) The ME degree is a non-thesis course of study designed for those who are interested in broadening their general knowledge of Biological Systems Engineering, rather than specializing in one specific area. Although a thesis is not required for this degree program, the students are required to complete a project report. Thirty credit hours, including 3 to 6 credit hours of Project and Report are required. This degree is not recommended for students who might be interested in pursuing a PhD degree. The students in a ME program are not eligible to receive research assistantships from the Department.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

PhD (post-MS) This option is for students who already have an MS degree and would like to continue their academic career in order to receive a PhD. The PhD is the highest academic degree awarded by the University and is conferred upon a student who demonstrates outstanding original scholarship during advanced study. It signifies that the student is able to conduct independent research and has both a broad basic knowledge of all areas of the field and a comprehensive knowledge of one area. A student who wishes to qualify for the degree is expected to meet the requirements of both the Graduate School and the Department. Direct PhD The Direct Admit to PhD (Direct PhD) program is for exceptional students with research experience who have a BS degree and want to be admitted to the Direct PhD Program without completing an MS degree. These students should have excellent academic records with a minimum grade point average of 3.5 (for the last 60 credit hours) and should be able to provide evidence of research activities to indicate their ability to synthesize information and conduct research experiments. Annual evaluations of the Direct PhD students will be conducted by the Graduate Committee and the student's Advisory

Committee. If it is determined that the student does not possess the ability to successfully complete a PhD degree, the Advisory Committee and the Department would consider awarding a non-thesis MS degree, provided that all university requirements for this degree are met by the student. Successful students will proceed with their program and follow all Departmental policies and procedures established for the PhD program.

GRADUATE COURSES (BSE)

BSE 5044 (BMES 5044) (CHE 5044):

Engineering Mathematics

Introduction to numerical solutions of partial differential equations using the finite element method in one-, two-, and three-dimensions with direct relevance to chemical engineering, biological systems engineering and biomedical engineering and sciences. Partial differential equations and ordinary differential equations using finite differences, model parameter sensitivity analysis, optimization, and data analysis. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BSE 5114:

Advanced Properties of Biological Materials

Theory and measurement of fundamental physical and engineering properties important to handling, modifying, processing, and and characterizing biological materials. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4574 (UG) OR ESM 4574

Corequisite(s):

BSE 5214:

Advanced Topics in Watershed Management

An interdisciplinary exploration of advanced topics in watershed management. Reading, discussion, summary and presentation of current research in the areas of water quality and watershed management.

Topics will be built around a semester theme that will vary by semester; the course may be repeated up to three times. Graduate standing required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BSE 5224G:

Advanced Field Methods in Hydrology

Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrological 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: GLP practices, selection of analytical method, calibration, QA/QC. Pre:

Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BSE 5244 (CEE 5244):

Advanced GIS in Hydrologic Analysis

Advanced GIS course focusing on raster analysis with particular application to the issues associated with hydrologic analysis. Application and evaluation of algorithms for terrain analysis, watershed characterization, and hydrologic analysis and modeling as implemented in GIS. Digital elevation data sources and error assessment. Approaches to GIS/model integration and application.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): BSE 4344 (UG) OR CEE 5204 (UG) OR GEOG 4084 (UG), BSE 3305 (UG) OR CEE 4304 (UG)

Corequisite(s):

BSE 5344G:

Applied Geographic Information Systems

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 required. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BSE 5354:

Nonpoint Source Pollution Modeling

Examination of the fundamental structure of nonpoint source pollution models, considering components, parameters and dependent variables, governing mathematical relationships; spatial variation of inputs; upland sediment and nutrient transport; and nonpoint source pollution control planning. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BSE 5304 (UG) OR BSE 5304 (UG)

Corequisite(s):

BSE 5364:

Stream Restoration

Stream restoration practices related to channel dynamics, sediment transport, impact of human activities, aquatic habitat improvements, and design and assessment. Inspecting, classifying, identifying and measuring river features of channel morphology to predict river reaction to human activities and watershed change. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BSE 5404:

Agricultural Nonpoint Source Pollution

Assessment and management of agricultural nonpoint source pollution (NPS). Precipitation, runoff, erosion, pollutant fate and transport, and best management practices. Application of Total Maximum Daily Loads and water quality standards. Pre: Background in physical, chemical, biological, and soil factors affecting the environment and in environmental regulations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BSE 5504G:

Adv. Bioprocess Engineering

Study of engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Emphasis is placed on enzyme kinetics and technology, bioreaction kinetics, design, analysis, and control of bioreactors and fermenters, and downstream processing of bioreaction products. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BSE 5544G:

Advanced 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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): BSE 3504 (UG) OR BSE 3504 OR CHE 3144 (UG) OR CHE 3144

Corequisite(s):

BSE 5604:

Advanced Food Process Engineering

Design of food processing operations including microwave cooking, frying, and extrusion. New food processing technologies including ohmic, radio frequency, high pressure, and pulsed electric field processing. Simulation of food processing systems. Procedures for optimizing formulations or processes. Odd years. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BSE 3504 (UG), BSE 4604 (UG)) OR (BSE 3504, BSE

4604)

Corequisite(s):

BSE 5614:

Advances in Recombinant Protein Production

Concepts, principles and applications of various expression systems for recombinant protein production, and the principles and applications of the most current unit operations used in bioseparations. The principles and applications of various methods for protein molecular modification to facilitate its downstream processing. Design of processes for protein purification based on expression systems, protein properties, and the impurities to be eliminated. Case studies in recombinant protein expression, recovery and purification. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BSE 5624:

Enzyme Engineering

Latest advances in industrial applications of enzymes, kinetic models on solid substrates, protein engineering tools (rational design and directed evolution), and cell-free synthetic enzymatic pathway biotransformations for the production of biofuels and bioelectricity. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BSE 5644:

Biobased Ind Polymers

Importance of biological feedstocks (i.e., proteins, polysaccharides, and fats) to industrial polymers and the future economy. Chemistry and processing of biological feedstocks into polymers. Properties of biobased polymers. Pre-requisites: Graduate Standing and Knowledge of thermodynamics, transport phenomena, and organic chemistry required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Corequisite(s):

BSE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BSE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

BSE 5944:

Seminar

Selected presentations and discussions by graduate students and faculty.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BSE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BSE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

BSE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BSE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CHEMICAL ENGINEERING

David Cox, Head

Professors: Luke Achenie; Donald Baird; David Cox; Richey Davis; William Ducker; Erdogan Kiran; Yih-An Liu;

Associate Professors: Aaron Goldstein; Ayman Karim; Chang Lu; Stephen Martin; Padmavathy Rajagopalan;

Assistant Professors: Abby Whittington; Hongliang Xin;

Alexander F. Giacco Professor: Donald Baird;

Frank C. Vilbrandt Professor: Yih-An Liu;

Graduate Coordinator: dianec@vt.edu

Graduate Chair: wducker@vt.edu

Department Head: dfcox@vt.edu

Department Site: <http://www.che.vt.edu>

Overview of ChE Graduate Program Chemical engineering has and will continue to play a prominent role in all realistic solutions to national and international problems of energy, environment, and food. Progress toward solutions in these areas rests with judicious application of science. Such is the domain of the chemical engineer. The graduate plans of study in chemical engineering are heavily oriented toward synthesis as well as the usual emphasis upon analysis. There is a strong thread of physics, chemistry, mathematics, biochemistry, and microbiology in much of the research in the department. Active research areas include polymer science and engineering, colloid and surface chemistry, solid state chemistry and physics, nanotechnology, applied thermodynamics, molecular modeling, biochemical and tissue

engineering, catalysis and surface science, design for sustainability, green engineering, computer-aided design, and supercritical fluid science and technology. This representative list of topics gives an indication of the breadth and diversity of research areas in the department. Programs are also available for students with undergraduate degrees other than chemical engineering. Chemistry majors, especially those with thorough backgrounds in physical chemistry and mathematics, as well as graduates in biochemistry and microbiology, can re-orient their studies. The applied science nature of the research in the department facilitates this reorientation process for such students. Ph.D. programs to meet the needs of these students generally may require additional courses. The Ph.D. and M.S. degrees include a core of 14 credits in transport phenomena, thermodynamics, kinetics and mathematics. These courses are supplemented with electives chosen in support of the thesis research or the student's special interests. The Ph.D. is awarded only to those students who demonstrate the initiative and ability to carry through a significant research program, resulting in a thesis. A thesis is required of all M.S. degree students. Much of the research in the department involves multidisciplinary efforts; as such, chemical engineering students develop strong interactions with students and faculty in and out of the department and across colleges.

SPECIAL FACILITIES

The Chemical Engineering Department has state-of-the-art experimental facilities for the chemical, physical and biological characterization of materials. Computational resources include a departmental cluster and campus-wide supercomputing facilities.

Bio-Nanomaterials Lab

Research in this lab concerns the self-assembly of polymers at interfaces and the engineering of nanostructured particles for drug delivery and medical imaging applications. A major focus is on the formation and characterization of nanoparticles with well-defined size distributions and compositions. Specific examples include nanoparticles of block polymers that bind drugs and superparamagnetic iron oxide particles for imaging biodistribution, nanoparticles consisting of polysaccharides and drugs for oral drug delivery, and metal nanoparticles with tailored optical properties for applications in chemical sensing and imaging applications. The lab is equipped with instrumentation to characterize the size distributions, surface chemistry, compositions, and related properties of nanoparticles.

Colloidal Dispersions Lab

This lab is focused on measuring the physical properties of dispersions of colloidal particles in liquids. State-of-the-art instruments are available for measuring rheology, zeta potential, particle size distribution, and streaming potential.

Environmental Catalysis and Nanomaterials Laboratory

Research is being carried out in two major fields, membranes and catalysis. In the membrane area, work is being carried out in the discovery of new inorganic membranes for H₂O and CO₂ separations, their characterization with advanced tools, and their application in reactors that combine reaction and separation or delivery. In the catalysis area efforts are directed in the development of new

compositions for biomass conversion and the understanding of their function at the molecular level using in situ methods.

Laboratory for Biomaterials and Tissue Engineering

Research focuses on the development of model tissue constructs or functional tissue units and the study of cell-substratum interactions. A primary goal is to design tissue constructs that mimic the native structure of tissues in vivo and to systematically probe cellular response to a variety of cues. This involves the fabrication of biocompatible scaffolds and templates, and more importantly tailoring surface and bulk properties. Another research interest is to quantify cell-substratum interactions. Specifically studies focus on how chemical and mechanical properties of an underlying substratum affect cellular motility and contractility.

Membrane Characterization Lab

The research focus is on the development and characterization of new membrane materials for gas separations and water desalination and purification. Gas separations include natural gas, air and hydrocarbon separations. Equipment includes constant volume permeability set-up, IGA sorption analyzer and GE cross-flow liquid transport unit.

Microfluidics Lab

Development of microfluidic devices for studying cells and biomolecules. Research also focuses on understanding microscale fluid mechanics.

Multiscale and Multiphysics Modeling Lab

This facility specializes in large-scale modeling and scientific computing of chemical and reactive processes. The facility has a medium size Beowulf style high computing environment.

Polymer Rheology and Processing Lab

This laboratory is equipped with devices for measuring the basic flow properties of polymeric fluids and their composites and small scale processing facilities for converting the fluids into useful materials. The basic flow properties are used in the design of processes for converting these fluids into materials with optimum performance and properties. Computing facilities are available for numerical simulation of polymer processing operations.

Prediction and Measurement of Surface Forces Lab

Surface Chemistry and Engineering. This lab is dedicated to discovering and altering the properties of solid-liquid interfaces, including wetting, adsorption, and the stability of colloidal dispersions. A significant component of the research is in the measurement and understanding of both equilibrium forces and viscous forces that occur on small particles in water and air.

Soft Materials Laboratory

Research focuses on the synthesis, characterization and applications of soft materials, including surfactants, thin films, liquid crystals, liquid crystal polymers, and block copolymers. Particular emphasis is placed on the relationship between structure in soft materials, and control of material properties. Applications include membranes for gas, liquid, and

chiral separations; functional and responsive surfaces; and polymer processing.

Supercritical Fluids and High Pressure Lab

This is a highly specialized laboratory for investigations of thermophysical properties of dense or supercritical fluids and fluid mixtures at high pressures, up to 1000 bar at 200 oC. The focus is on thermodynamic and kinetic aspects of miscibility and phase separation and transport properties of dense fluid mixtures with emphasis on applications for polymer formation, modification and processing.

Ultrahigh Vacuum Surface Science Lab

Capabilities for chemical and structural characterization of solid surfaces and surface reactivity using photoemission, electron diffraction, and temperature programmed desorption experiments.

DEGREES OFFERED

MEng Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

MEng (Project & Report) - Total of 30 credit hours. minimum of 24 graded credit hours maximum of 6 credit hours of Project & Report (5904) may include maximum of 6 credits of 4000-level undergraduate course work all other graded course work must be 5000-level or higher and may include: 3 credits of seminar and a maximum of 9 credits total in 5974, 5984 and 6984 MEng (non-thesis) - Total of 30 credit hours. minimum of 30 graded credit hours may include a maximum of 6 credits of 4000-level undergraduate course work all other graded course work must be 5000-level or higher and may include: 3 credits of seminar and a maximum of 9 credits total in 5974, 5984 and 6984

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

PhD - Total of 90 credit hours. minimum of 27 graded credit hours may include a maximum of 6 credits of 4000-level undergraduate course work all other graded course work must be 5000-level or higher and may include: 4 credits of seminar and a maximum of 18 credits total in 5974, 5984 and 6984 minimum of 30 credit hours of Research & Dissertation (7994)

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

MS (thesis) - Total of 30 credit hours. minimum of 20 graded credit hours may include a maximum of 6 credits of 4000-level undergraduate course work all other graded course work must be 5000-level or higher and may include: 3 credits of seminar and a maximum of 6 credits total in 5974, 5984 and 6984 minimum of 6 credit hours of Research & Thesis (5994)

GRADUATE COURSES (CHE)

CHE 5014 (MSE 5014) (CHEM 5014):

Communication Skills and Methods of Presentation

Methods and style to make effective technical and nontechnical presentations including blackboard presentations, overhead presentations, slide presentations, and research posters. Video presentations with critiques.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5034:

Introduction to Polymer Materials

Homopolymerization, copolymerization, polymer, architecture, morphology, thermal transitions, vitrification, crystallization, polymer solutions, blends, thermodynamics of miscibility and phase behavior, and mechanisms and kinetics of pressure- or temperature- induced phase separation, formation of particles, fibers, porous matrices or scaffolds, and novel technologies employing modifications and processing in or with dense or supercritical fluids, or ionic liquids. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5044 (BSE 5044) (BMES 5044):**Engineering Mathematics**

Introduction to numerical solutions of partial differential equations using the finite element method in one-, two-, and three-dimensions with direct relevance to chemical engineering, biological systems engineering and biomedical engineering and sciences. Partial differential equations and ordinary differential equations using finite differences, model parameter sensitivity analysis, optimization, and data analysis. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5064:**Solids & Solid Surfaces**

Introduction to the theory of solids. Physical properties of bulk crystalline solids and their surfaces are discussed. Excitations accompanying the interaction of electrons and photons with solids are discussed to provide a basis for understanding a variety of experimental methods used in the characterization of solids. Methods for characterizing geometric and electronic structure are surveyed with an emphasis on techniques of ultrahigh-vacuum surface science.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5084:**Heterogeneous Catalysis**

Fundamental aspects of heterogeneous catalysis; absorption, surface reactions, and catalyst preparation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHE 3184 (UG) OR CHE 3184

Corequisite(s):

CHE 5094:**Advanced Chemical Engineering Kinetics**

Fundamental principles of chemical kinetics applied to the analysis and

design of chemical reactors. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHE 3184 (UG) OR CHE 3184

Corequisite(s):

CHE 5125:**Transport Phenomena**

Fundamentals aspects of transport of mass and chemical reaction.

Application to complex chemical engineering problems. Advanced mathematical techniques, fundamental aspects of transport of mass, and chemical reaction. Application to complex chemical engineering problems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHE 3044 (UG), CHE 3144 (UG)) OR (CHE 3044, CHE 3144)

Corequisite(s):

CHE 5126:**Transport Phenomena**

Fundamentals aspects of transport of mass and chemical reaction.

Application to complex chemical engineering problems. Advanced mathematical techniques, fundamental aspects of transport of mass, and chemical reaction. Application to complex chemical engineering problems. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHE 3044 (UG), CHE 3144 (UG), CHE 5125 (UG)) OR (CHE 3044, CHE 3144, CHE 5125)

Corequisite(s):

CHE 5144:**Advanced Thermodynamics**

Fundamentals of physical and chemical equilibria, statistical thermodynamics, and applications to situations of current special interest. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHE 2164 (UG) OR CHE 2164

Corequisite(s):

CHE 5164:

Process Dynamics and Simulation

Advanced techniques for modeling and simulation of chemical processing systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHE 5125 (UG), CHE 5144 (UG)) OR (CHE 5125, CHE 5144)

Corequisite(s): CHE 5094, CHE 5126

CHE 5214 (BMES 5434):

Polymeric Biomaterials

Topics include polymer design and processing, inflammatory responses to polymers, interaction of blood with polymeric materials, and the effect of mechanical, chemical, and surface properties of polymers on cells.

The culmination of this course will provide students with the knowledge to successfully design polymer-based biomaterials, drug-delivery devices, and bio-implants. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5304 (BMES 5304):

Biological Transport Phenomena

The fundamental principles of mass transport phenomena will be introduced and applied to the characterization of transport behavior in biological systems (e.g., cell, tissues, organs, people). Topics will include active, passive, and convective molecular transport mechanisms. These fundamentals will be used to develop analytical and predictive models that describe phenomena such as oxygen transport, kidney function, systemic drug delivery, and design of extracorporeal devices. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHE 3114 (UG) OR CHE 3114), (CHE 3044 (UG) OR CHE 3044 OR CHE 3144 (UG) OR CHE 3144) OR (ME 3304 (UG) OR ME 3304, ME 3404 (UG) OR ME 3404)

Corequisite(s):

CHE 5314:

Hazardous Waste Treatment

Background on regulations and fundamentals of techniques used for treating hazardous wastes, ground water, and leachates.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 2535

Corequisite(s):

CHE 5334G:

Colloid and Interface 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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CHE 5544G:

Advanced 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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHE 3144 (UG) OR CHE 3144 OR BSE 3504 (UG) OR BSE 3504

Corequisite(s):

CHE 5564:

Development of fluid models which describe the mechanical response of non-Newtonian fluids. Use of these models with the basic equations of continuum mechanics is emphasized.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHE 3114 (UG) OR CHE 3114

Corequisite(s):

CHE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CHE 5944:

Chemical Engineering Seminar

This course is designed to improve a student's ability to present formal seminars concerned with technical and nontechnical information.

Numerous presentations are given by each student enrolling in this class.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

CHE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CHE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CHE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CIVIL ENGINEERING

William Easterling, Head

Emeriti Faculty: J Duncan; James Mitchell; Thomas Murray; John Novak; Clifford Randall;

Professors: Gregory Boardman; Finley Charney; Thomas Cousins; Andrea Dietrich; Thomas Dingus; William Easterling; Marc Edwards; George Filz; Gerardo Flitsch; Russell Green; Antoine Hobeika; William Knocke; Roberto Leon; John Little; Linsey Marr; Glenn Moglen; Amy Pruden-Bagchi; Hesham Rakha; Carin Roberts-Wollmann; Sunil Sinha; Antonio Trani; Peter Vikesland; Linbing Wang; Mark Widdowson; Jesus de la Garza;

Associate Professors: Montasir Abbas; Thomas Brandon; Randel Dymond; Daniel Gallagher; Michael Garvin; Kathleen Hancock; Zhen He; Kevin Heaslip; Jennifer Irish; Matthew Mauldon; Cristopher Moen; Pamela Murray-Tuite; Adrian Rodriguez-Marek; Kamal Rojiani; Kyle Strom; John Taylor;

Assistant Professors: Matthew Eatherton; Erich Hester; Ioannis Koutromanos; Denise Simmons; Nina Stark; Deborah Young-Corbett; Katerina Ziotopoulou;

Vecellio Professor: Jesus de la Garza;

Newport News Shipbuilding/Tenneco Professor: Thomas Dingus;

Associate Professor of Practice: Joseph Dove;

Montague-Betts Professor: William Easterling;

Charles P. Lunsford Professor: Marc Edwards;

Charles E. Via, Jr. Professor: George Filz; John Little;

Research Associate Professors: Adil Godrej;

W. Curtis English Professor: William Knocke;

Samuel Reynolds Pritchard Professor: Hesham Rakha;

David H. Burrows Professor: Roberto Leon;

Assistant Professor of Practice: Bryan Katz; Victoria Mouras; Robert Scardina;
Kevin Young;

Research Assistant Professors: Celal Olgun; Husen Zhang;

Graduate Contact: leigha@vt.edu

Student Handbook:

http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

Graduate Site:

http://www.cee.vt.edu/prospective_students/graduate_programs/prospective_graduate_students.html

The Charles E. Via, Jr. Department of Civil and Environmental Engineering awards the Master of Science in civil engineering, the Master of Science in environmental engineering, the Master of Engineering in civil engineering, and the Doctor of Philosophy in civil engineering. A Master of Science degree in environmental sciences and engineering are also administered within the department. For the civil engineering degrees, students may emphasize one or more of 10 discipline areas available for graduate study within the Department: civil engineering materials, civil infrastructure engineering, construction engineering and management, environmental engineering, geospatial engineering, geotechnical engineering, hydrosystems engineering, structural engineering, and transportation engineering. A minor may also be taken in one or more of the alternate branches of engineering or in an allied field, such as mathematics, engineering mechanics, chemistry, geology, or urban and regional studies. As part of a land-grant University, the department strives to provide a mix of applied and theoretical learning and research opportunities. Success at achieving these goals and in offering attractive graduate study opportunities can be measured by the fact that graduate programs have grown substantially over the past 15 years, while student qualifications have also improved. Today, the graduating classes typically include approximately 125 MS degrees, and 20 Ph.D. degrees. The graduate enrollment of approximately 320-360 on the main campus and another 50 students at extended campuses make this program one of the largest in the Southeast. The department routinely ranks in the top 10 civil engineering programs in the United States. Likewise, certain graduate program areas are ranked among the best available in the U.S. The department has 53 full-time and seven active emeritus faculty members, of which three are members of the National Academy of Engineering, one is a member of the National Academy of Science, two are members of the National Academy of Construction, and eight hold prestigious named professorships. Fourteen members of the faculty have been awarded Presidential Young Investigator, National Young Investigator, or CAREER awards from the National Science Foundation. Two have been awarded the prestigious PECASE Award and seven have been awarded the State Council of Higher Education for Virginia Outstanding Faculty Award. Faculty members within the department have received numerous national and regional awards for their teaching, research, scholarship and outreach activities. Financial resources are available to support graduate students via a variety of funding mechanisms. The department annually awards the full-time equivalent of more than 40 graduate teaching assistantship positions. In addition, annual research expenditures (averaging approximately \$15 million dollars) provide numerous opportunities for students to receive graduate research

assistantships. Finally, the Via Endowment (established at \$5 million dollars in 1987, now valued at nearly \$15 million dollars) provides special funds for fellowships that support the highest quality M.S. and Ph.D. students (U.S. citizenship or permanent residency required for Via support) who pursue graduate studies in the department. The Via Endowment also provides special stipend support for a select number of Ph.D. students who receive an opportunity to pursue classroom instruction each year. While the majority of the department's graduate activities occur in Blacksburg, there are also opportunities available in other areas of the Commonwealth of Virginia. Through a combination of full- and part-time resident faculty, the department offers several graduate program emphasis areas (civil infrastructure engineering, construction engineering and management, environmental engineering and sciences, and advanced transportation systems) through the University's Northern Virginia Center in Falls Church. In addition, the department offers graduate degree opportunities in civil infrastructure engineering and environmental engineering via the Virginia Cooperative Graduate Education Program, a distance learning program that provides engineering courses throughout the Commonwealth by live transmission of courses.

SPECIAL FACILITIES

The CEE department has a wide range of facilities to support its teaching and research goals.

CEECL Computer Laboratory

This instructional lab provides multimedia equipment (Computer, VCR, ELMO, LT) for faculty/staff to instruct audiences in the use of installed engineering software. The podium allows an instructor to project two independent video signals simultaneously on two separate screens. The primary purpose of this room is instruction for CEE courses and special classes

Kelso Baker Environmental Hydraulics Lab

Baker Environmental Hydraulics Laboratory (BEHL) is a 3100 square ft floor area facility, housing several research flumes and a wide variety of advanced research instrumentation and hydraulic measurement systems. The laboratory is devoted to environmental hydraulics related research.

Materials Laboratory

The materials laboratory provides 7700 sq. ft. of research space and contains equipment for evaluation of the performance of concrete and asphalt. Concrete and concrete- making materials performance evaluation equipment include rapid and critical dilation freezing and thawing cabinets, a computer-driven microscopic air void analysis apparatus, corrosion rate measuring devices, state-of-the-art image analysis system, petrographic microscope, and facilities for wet chemical analysis.

Occoquan Monitoring Laboratory (Manassas, VA)

The Occoquan Watershed Monitoring Laboratory (OWML), Manassas, is responsible for making determinations in a number of areas critical to the ongoing management of water quality in the Occoquan watershed, situated on the southwestern periphery of the Virginia suburbs of

including portions of four counties, and the entire land area of two independent cities.

Structures Laboratory

The Structures and Materials Research Facility is located on the campus of Virginia Tech. The laboratory provides the structural and materials faculty the necessary equipment to conduct performance evaluations of civil engineering materials, and to conduct experimental research utilizing full-scale structural components. A total of 27,000 sq. ft. of laboratory and office space is available.

Virginia Tech Transportation Institute (VTTI)

The Virginia Tech Transportation Institute (VTTI) continues to serve as Virginia Tech's largest university-level research center and is dedicated to conducting research to save lives, save time and save money in the transportation field by developing and using state-of-the-art tools, techniques, and technologies to solve transportation challenges. Its cutting-edge research is effecting significant change in public policies in the transportation domain on both the state and national levels.

W.C. English Geotechnical Research Laboratory

The W.C. English Geotechnical Research Laboratory is the most advanced of its kind in Virginia and the mid-Atlantic region. The \$1.1 million facility, located approximately one mile from campus, has spacious rooms, filled with specialized instrumentation. This laboratory boasts 6,100 square feet of research space.

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Leesburg, Blacksburg, Richmond)

TOEFL

Paper: (570.0)

Computer: (230.0)

iBT: (88.0)

GRE

General Test: Verbal, Quantitative, Analytical

See Departmental Manual at
http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

Degree Concentrations:

Program Area Concentrations

Construction Engineering and Management Environmental and Water Resources Engineering Geotechnical Engineering Structural Engineering and Materials Transportation Infrastructure and Systems Engineering

Interdisciplinary Program Area Concentrations

Civil Infrastructure Engineering Geospatial Engineering

MEng Degree

Offered In (Blacksburg)

TOEFL

Paper: (570.0)

Computer: (230.0)

iBT: (88.0)

GRE

General Test: Verbal, Quantitative, Analytical

See Departmental Manual at
http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (570.0)

Computer: (230.0)

iBT: (88.0)

GRE

General Test: Verbal, Quantitative, Analytical

See Departmental Manual at
http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

Degree Concentrations:

Program Area Concentrations

Construction Engineering and Management Environmental and Water Resources Engineering Geotechnical Engineering Structural Engineering and Materials Transportation Infrastructure and Systems Engineering

GRADUATE COURSES (CEE)

CEE 5010:

Schedule Impact Analysis

Analysis of construction scheduling principles, scheduling specifications, contract administration, construction law, construction delay claims, and of accepted methodologies for performing schedule impact analysis of delaying events.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4024 (UG) OR CEE 4024

CEE 5014:**Facility Delivery & Financing**

Delivery and financing of constructed facilities with an emphasis upon civil infrastructure systems. Design of project delivery systems to encourage best value, innovation, and private sector participation. Public-private partnership strategies and factors that contribute to success or failure. Fundamentals of project feasibility, evaluation, and finance. Case studies of large-scale infrastructure projects. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5024:**Contract Administration and Claims Resolution**

This course provides students with a knowledge of the different types of contracts used in civil engineering construction. Contracts are viewed as documents which assign responsibilities and allocate risks and emphasis is placed on contract administration as the first step in reducing costs and easing the burden of dispute resolution. Techniques for quantifying and resolving claims are studied. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5034:**Construction Systems Design and Integration**

This course will study building systems, their design and how to best manage the life cycle cost of the systems. The course will have particular emphasis on systems. The course will have particular emphasis on mechanical and electrical equipment in buildings, solar design, lighting design, site orientation, value engineering and constructability of the various systems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5040:**Design of Construction Operations**

Design and analysis of construction operations using discrete-event simulation modeling. Modeling construction operations using activity cycle diagrams. Collection and reduction of construction data. Selection of distribution models and estimation of parameters. Goodness of fit testing. Assessment of independence and autocorrelation. Design of simulation experiments. Output analysis and confidence intervals of performance measures. Variance reduction techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5044:**Construction Research Presentation**

This course requires that students produce a written paper and make an oral presentation based on a construction research topic of their choice.

It is designed to sharpen skills in the written and oral presentation of technical material. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): CEE 6014

CEE 5050:**Construction Decisions Under Uncertainty**

Construction project and organization decisions for the uncertain future. Selection of construction methods, equipment, project and operation attack strategies, contract, markup, and financing alternatives having the highest expected values and utilities. Use of decision and utility theory, competitive bid analysis, and probabilistic modeling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5054:**Construction Performance Improvement**

Skills for productivity improvement in construction, with special attention

develop and implement efficient and rewarding methods. Consideration of the human factor in generating and implementing commitments to productivity improvements. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3014 (UG) OR CEE 3014

Corequisite(s):

CEE 5064G:

Design Hazard Control Construct

Design of construction projects and systems to control inherent hazards to the health and safety of construction workers, inhabitants of the built environment, and the general public. Regulatory and legal factors pertinent to construction, chemical and physical health hazards, major classes of safety hazards, design processes, and specifications to control safety and health hazards, system engineering risk analysis tools, and safety management processes. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5070:

Equipment Economics and Applications

Methodologies for determining the owning and operating cost and economic life of construction equipment. Application of engineering economics to equipment management decisions with particular reference to maintain, rebuild, replace decisions. Techniques to analyze equipment intensive operations, determine actual and delay free cycle times, match individual units and balance fleets. Synthesis of knowledge regarding production and cost to optimize productivity and reduce unit costs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5074:

Global Virtual Design and Construction

Fundamental aspects of modern civil engineering project execution in

virtual workspaces. Participation in team-based virtual design and construction project involving students from other domestic and international universities. Design of organizational and task model, integration with design and cost models, identification of interventions that improve scheduling. Strengthened ability to work collaboratively with individuals from different countries/cultures. Both theory and practice emphasized. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5080:

Infrastructure Asset Mgt

Comprehensive systems approach to civil infrastructure system and strategic-level asset management with emphasis on municipal, highway, building, dam, and bridge infrastructure. Course will cover various aspects of strategic-level infrastructure asset management: systems thinking, needs assessment, information technology and GIS data management, risk and reliability engineering, multi-criteria decision making process, infrastructure sustainability and resiliency, and renewal engineering (repair, rehabilitation, and replacement). Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5084:

Information Technology for Infrastructure and Environment Systems

With the acceleration of the process of global revolution in science, engineering and technology led by information technology, the human society is in a gradual transition from an industrial society into an information society. As a new productivity with the greatest potential at the present age, information technology has undergone great development. The incessant innovation in technology has also urged people to make better use of it and apply advanced information technology to their own industry. In recent years, Information Technology (IT) and Cyber Infrastructure has been transforming engineering and business practices in many sectors, resulting in efficiency gains and improved services for the client. The infrastructure industry has been slow to utilize information technology effectively and slower still to grasp

the ways in which the multitude of design, calculation, specification, project management, asset management, sensor technology, database and data analysis software applications relate to each other. This course provides an overview of the range of Information Technology (IT) applications available to the civil and environmental professional throughout the life cycle of a project, from data collection and analysis through software, project management, environmental impact analysis, visualization, and infrastructure asset management. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5094:

CII Best Practices

Introduction to Construction Industry Institute (CII) Best Practices, including Front End Planning Zero Accident Techniques, Constructability, and Material Management that affects construction projects. Management influences on construction processes and critical issues. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5104:

Environmental Chemistry

Applied, environmental aspects of physical, organic, and inorganic chemistry; including applications in sanitary engineering of the phenomena of precipitation, complexation, buffering capacity, and chemical equilibria. Review of the nomenclature and properties of organic compounds.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5124:

Fundamentals of Environmental Toxicology

Introduction to nomenclature, principles, and scope of environmental

toxicology. The fate and effects of both organic and inorganic toxicants in the environment, in animals, and in various test systems. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5104 (UG) OR CEE 5104

Corequisite(s):

CEE 5125:

Environmental Engineering Design

5125: Design of wastewater treatment facilities for the reduction and elimination of organic and inorganic pollutants; 5126: Design of water treatment facilities for the production of potable waters from surface and groundwater systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s):

CEE 5126:

Environmental Engineering Design

5125: Design of wastewater treatment facilities for the reduction and elimination of organic and inorganic pollutants; 5126: Design of water treatment facilities for the production of potable waters from surface and groundwater systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5130G:

Adv Indoor Enviro Qual Sustain

Indoor environmental quality factors and associated sustainable design methods and approaches. Air contaminant sources, emission and dispersion patterns, health impacts, and control solutions. Methods of improving IEQ through material and ventilation solutions. Applicable regulatory requirements and sustainability organization recommendations will be reviewed. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5134:

Engineering Aspects of Water Quality

The application of biological, chemical, and physical principles of water quality to engineering problems in surface waters.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s):

CEE 5144:

Unit Operations and Processes Laboratory

Applied science aspects of water and waste treatment; advanced research techniques in analysis and treatment of water and wastes.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (CEE 5125 (UG) OR CEE 5126 (UG)) OR (CEE 5125 OR CEE 5126)

Corequisite(s):

CEE 5154:

Air Pollution Transport and Chemistry

Principles and practice of air pollution source control with emphasis on stationary source control and equipment operating and design parameters; economic and technical evaluation of control system design alternatives.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5174:

Industrial and Hazardous Wastes Control

Contemporary methods for the management and treatment of industrial wastewaters, including in-plant reductions and reuse. Characterization and management of hazardous wastes. Design of appropriate systems.

II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5134 (UG) OR CEE 5134

Corequisite(s):

CEE 5184:

Techniques for Environmental Analysis

An introductory course on techniques commonly utilized for analysis of environmental samples. Course will discuss gas and liquid chromatography, mass spectrometry, and atomic absorption spectroscopy, focusing on analysis of complex environmental samples. Practical techniques and applications are emphasized, but sufficient theory is introduced to provide students with an understanding of the principles involved.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5194:

Environmental Engineering Microbiology

Roles of microorganisms in wastewater treatment, anaerobic digestion of municipal sludges, stream self-purification, and degradation of water quality in drinking-water systems. Disinfection of wastewater and drinking water to remove viruses, bacteria, and protozoa that cause waterborne disease.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

CEE 5204:

Gis Applications in Civil Engineering

Examination of data structures used in geographic information systems. Map projections and coordinate systems used in mapping. Database creation, maintenance, and integrity. Applications of GIS methods for solving civil engineering problems in land management and related areas. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

297 Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5224:

Advanced GIS Applications in Civil and Environmental Engineering

This project based course deals with both vector and raster Geographic Information Systems (GIS), network analysis, tracking applications, hydrologic applications, spatial analysis, web databases, and linking GIS to models with programming, specifically in the civil and environmental engineering arena. Pre: Any introductory GIS course, including CEE 5204, GEOG 4084, or BSE 4344. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5244 (BSE 5244):

Advanced GIS in Hydrologic Analysis

Advanced GIS course focusing on raster analysis with particular application to the issues associated with hydrologic analysis. Application and evaluation of algorithms for terrain analysis, watershed characterization, and hydrologic analysis and modeling as implemented in GIS. Digital elevation data sources and error assessment. Approaches to GIS/model integration and application.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (BSE 4344 (UG) OR CEE 5204 (UG) OR GEOG 4084 (UG), BSE 3305 (UG) OR CEE 4304 (UG)) OR (BSE 4344 OR CEE 5204 OR GEOG 4084, BSE 3305 OR CEE 4304)

Corequisite(s):

CEE 5264G:

Advanced 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5304:

Environmental Fluid Mechanics

The first part of the course will be devoted to basic concepts and equations of fluid motion. The remainder of the course will be concerned with the theory of incompressible viscous and inviscid fluids. Selected applications will be drawn from environmental and water resources topics. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3314 (UG) OR CEE 3314

Corequisite(s):

CEE 5314:

River Mechanics and Sediment Transport

Sediment properties; critical stress; bed-form regimes in alluvial streams; depth-discharge relations for rivers; bed load and suspended load movement; river stability; flow in bends; river training.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4324 (UG) OR CEE 4324

Corequisite(s):

CEE 5324:

Advanced Hydrology

Applications of statistics to hydrology, floods, and droughts; flow generation models; mathematical models in physical hydrology; difference methods in flow routing; kinematic wave; evapo-transpiration; infiltration; and atmospheric processes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4304 (UG) OR CEE 4304

Corequisite(s):

CEE 5344:

Surface Water-Groundwater Interaction

Interaction (exchange) of surface water with groundwater at watershed, reach, sediment-patch scales including bidirectional hyporheic flows. Focus on streams and rivers, consideration of lakes. Steady and unsteady exchange hydraulics including laminar and turbulent flows. Exchange benefits and engineering goals including heat transfer, nutrient processing, and contaminant attenuation. Engineering

applications including conjunctive use of surface water and groundwater resources and impact of groundwater pumping on rivers. Field methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5354 (GEOS 5814):

Numerical Modeling of Groundwater

Theory and practice of numerical techniques are developed and applied to fluid flow and transport in ground-water flow systems. Governing equations are formulated using FD and FE techniques with appropriate BC's and IC's. Additional topics include: model conceptualization and grid design in multidimensional systems; practical applications of numerical models including calibration, validation, and prediction; concepts and techniques of advective transport using particle tracking and dispersive transport. Introduction to MODFLOW, MODPATH, MT3D, and others. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (GEOL 4114 (UG) OR CEE 4314 (UG)) OR (GEOL 4114 OR CEE 4314)

Corequisite(s):

CEE 5364:

Water Law

Analysis of law for allocation of surface and groundwater supplies, legal controls over water quality alteration, public rights of water use, and drainage law. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4804 (UG) OR CEE 4804

Corequisite(s):

CEE 5374:

Dynamics Groundwater

The theory of dynamics of fluids in porous media; fluid and matrix properties; transport equations; boundary and initial value problems; flow of immiscible fluids; dispersion. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4314 (UG) OR CEE 4314

Corequisite(s):

CEE 5384:

Transport Processes in Waterways

Advanced treatment of the mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow. Independent research project. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5404:

Plate and Shell Structures

Classical solutions of elastic plate theory; approximate methods; continuous plates; orthotropic plates. Theory of thin shells of revolution; membrane and bending actions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3404 (UG) OR CEE 3404

Corequisite(s):

CEE 5414:

Finite Element Analysis of Structures

Formulation of the finite element method and application to skeletal, plate, and shell structures. Study of mesh layout and refinement, convergence characteristics, and solution accuracy. Tests of element quality. Use of commercial finite element codes such as ABAQUS.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5424:

Computer Analysis of Structures II

Extension of matrix displacement method to skeletal space structures: space trusses, space frames, and grids. Incorporation of special features such as nonglobal constraints, assemblies of different types of elements,

thermal problems, substructuring, and buckling analysis. Development of well-structured programs on the mainframe and transfer to the personal computer.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4404 (UG) OR CEE 4404

Corequisite(s):

CEE 5424G:

Intermediate Design of Prestressed Concrete Structures

Principle of prestressing applied to concrete beams, slabs, and frames; design of individual elements and structural systems of prestressed concrete; precast construction and connection design. Graduate

Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3424 (UG) OR CEE 3424

Corequisite(s):

CEE 5430:

Intermediate Design of Steel Buildings

Design of major components in steel-framed buildings, including composite beams and slabs, beam-columns, and moment connections.

Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5434:

Design of Cold-formed Steel Structures

Behavior and design of cold-formed steel members. Strength of thin plate elements; flexural members; compression members, symmetric and non-symmetric; beam-columns; welded, bolted, and screw-fastened connections. Building systems that utilize cold-formed steel members. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3434 (UG) OR CEE 3434

Corequisite(s):

CEE 5444:

Stability of Structures

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 structural design criterion. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5454:

Elastic Stability

Stability of elastic structural components under conservative loads; precise definitions of stability; energy approaches; Rayleigh-Ritz and Galerkin methods; and applications to column, arches, plates, and shells. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3404 (UG) OR AOE 3124 (UG)) OR (CEE 3404 OR AOE 3124)

Corequisite(s):

CEE 5464:

Structural Dynamics and Earthquake Engineering

Earthquake-induced vibration of single- and multi-degree-of-freedom systems; application to frames and to shear and torsional buildings; response spectrum analysis; building codes; static and dynamic lateral force procedures; seismic resistance of steel and concrete building frames.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3424 (UG), CEE 3434 (UG)) OR (CEE 3424, CEE 3434)

Corequisite(s): CEE 4404

CEE 5470:

Structural Design for Seismic Load Effects

Analysis and design of steel and reinforced concrete structures for seismic load effects. Fundamental principles of earthquake engineering, 300

as rooted in seismic hazard analysis, inelastic behavior, and dynamic response. Application of these principles to the design and detailing of reinforced concrete and structural steel buildings. Building code requirements for seismic loading and seismic resistant design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3434 (UG), CEE 4404 (UG), CEE 5464 (UG)) OR (CEE 3434, CEE 4404, CEE 5464)

Corequisite(s):

CEE 5474:

Advanced Reinforced Concrete Design

Limit design concepts, yield-line methods, seismic considerations, and other advanced topics related to design of reinforced concrete structures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3424 (UG) OR CEE 3424

Corequisite(s):

CEE 5474G:

Intermediate Reinforced Concrete Structures

Behavior and design of continuous reinforced concrete structures subjected to gravity and lateral loads. Application of computer programs to frame analysis and design of members. Development length, biaxial bending of columns, continuous one-way beams and slabs, two-way floor systems, torsion, footing, and cantilever retaining wall design problems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3424 (UG)

Corequisite(s):

CEE 5484:

Concrete Bridge Design

Relationship of bridges to national needs; illustration of a preliminary design by case history; design of conventional bridge decks and girders; curved box-girder bridges; segmental construction; cable-stayed bridges; importance of design details on the seismic resistance of bridges.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3424 (UG), CEE 3434 (UG)) OR (CEE 3424, CEE 3434)

Corequisite(s):

CEE 5494:

Reliability Methods in Structures and Mechanics

Theory of structural reliability; reliability based designs, safety index, linear and nonlinear design equations, load and resistance factors, Level I, II and III formats, code formulations; systems reliability, bounds on reliability.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 4614 (UG) OR STAT 4706 (UG)) OR (CEE 4614 OR STAT 4706)

Corequisite(s):

CEE 5494G:

Intermediate Computer Methods on Structural Design

Design of structural members in steel, concrete, and wood using computers. Computer-aided design of structural systems. Development of computer programs for the solution of structural design projects.

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5504:

Risk Analysis Geotechnical Engineering

Methods for risk analysis of complex systems. Basic concepts of probability and reliability applied to geotechnical engineering problems. Geostatistics concepts. Probabilistic seismic hazard analysis and performance based design. Computational tools and simulation methods. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5514:**Soil Behavior**

Behavior of soil examined from a fundamental soil perspective. Review of methods of testing to define response; rationale for choosing shear strength and deformation parameters for soils for design applications. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3514 (UG) OR CEE 3514

Corequisite(s):

CEE 5524:**Advanced Soil Testing for Engineering Purposes**

Methods of testing and analysis of soil for engineering properties including compressibility; strength in triaxial, simple, and direct shear; permeability; and stability.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CEE 4524 (UG) OR CEE 4524

Corequisite(s):

CEE 5534:**Foundation Engineering I**

Behavior and design of retaining walls and shallow foundations. Earth pressures, bearing capacity, and settlement. Stress distribution and consolidation theories. Settlement of shallow foundations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3514 (UG) OR CEE 3514

Corequisite(s):

CEE 5544:**Foundation Engineering II**

Behavior and design of anchored bulkheads, excavation bracing, driven piles, drilled piers and buried structures. Effects of pile driving. Response of deep foundations to vertical and horizontal loads. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5534 (UG) OR CEE 5534

Corequisite(s):

CEE 5554:**Soil and Site Improvement**

Methods of soil and site improvement including design techniques for dewatering systems, grouting, reinforced earth, in-situ densification, stone columns, slurry trenches, and the use of geotextiles. Construction techniques for each system are described. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3514 (UG) OR CEE 3514

Corequisite(s):

CEE 5564:**Seepage and Earth Structures**

Soil permeability and seepage through soils. Embankment design. Compaction, earth pressures and pressures in embankments. Slope stability analysis. Settlements and horizontal movements in embankments. Landslide stabilization. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5514 (UG) OR CEE 5514

Corequisite(s):

CEE 5574:**Environmental Geotechnics**

Geotechnical aspects of environmental engineering projects. Fundamentals of soil behavior, site characterization, and contaminant transport; methods for geotechnical engineering practice for waste disposal, waste containment, and site remediation; waste landfills. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3104 (UG), CEE 3514 (UG)) OR (CEE 3104, CEE 3514)

Corequisite(s):

CEE 5584:**Geotechnical Aspects of Earthquake Engineering**

Causative mechanisms of earthquake, earthquake magnitudes, ground motion, effect of local soil conditions on motions. Response of soils to seismic loading, liquefaction phenomena and analysis of pore pressure development, laboratory and in-situ testing for seismic loading. Analysis

and design of slopes, embankments, foundations, and earth retaining structures for seismic loading. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4544 (UG) OR CEE 4544

Corequisite(s):

CEE 5594 (GEOS 5594):

Geological Engineering

Mechanical and hydraulic properties of rock masses; analysis and design of rock foundations, slopes, tunnels, and other forms of civil infrastructure; rock reinforcement. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5600:

Civil Infrastructure Systems Analysis

Systems analysis, modeling infrastructure systems by mathematical programming, measuring infrastructure systems performances, probabilistic analysis of infrastructure systems, multiple attribute decision making in infrastructure systems. Pre: Graduate standing in engineering is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5604:

Traffic Characteristics and Flow

Driver, vehicle, and roadway characteristics; stochastic modeling of traffic processes including queueing theory, headway distributions, and gap acceptance; stream flow characteristics including car-following and multilane traffic models, roadway capacity and bottleneck analysis, network operations, and fuel consumption models. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CEE 4604 (UG) OR CEE 4604

Corequisite(s):

CEE 5614:

Analysis of Air Transportation Systems

Planning, design and operation of aviation systems with computer aided design tools and computer simulation models. Airline airport operations and practices and their effect in airport planning and design. Air cargo facilities planning and modeling. State-of-the-art computer simulation models used in aviation environmental planning and airspace modeling. Graduate standing in CE required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5620:

Transportation Network Analysis

Optimal paths in transportation networks, transportation network design, vehicle routing and scheduling, facility location problems, traffic flows on networks, traffic assignment problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5624:

Transportation and Land Use

Interaction between transportation and land use variables, including modeling requirements, impacts, and data needs within the context of good community planning and economic development; elements of transportation and land use that shape the quality of life in urban areas. II

II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5630:

Design and Operation of Advanced Public Transportation Systems

An overview of the use of intelligent transportation systems (ITS),

public transit systems (APTS); emphasis is placed on communication, sensor application, information processing, traffic control, en-route and pre-trip information, electronic payment, and fleet management as they pertain to transit and paratransit services in large metropolitan areas as well as in small urban and rural communities.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5634:

Analysis and Planning of Mass Transit Systems

An overview of mass transit systems; transit system planning including demand and cost analysis and evaluation; transit system design including route design, scheduling, and fare policy; transit networks and marketing; para transit systems; future trends in mass transit. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5640:

Highway Transportation Safety

Identification of highway safety problems and development of solutions. User characteristics and expectations, road audits, roadside hardware systems, safety enhancing treatments, standard traffic control devices, real-time information and control systems, work zone and railroad crossing treatments, older driver design concepts, traffic calming, designs for pedestrians and bikes, delineation and lighting principles, and advanced 3D/4D design concepts. Group and individual analyses of problems. Pre: Graduate standing in engineering is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5644:

Transportation Systems Planning

Advanced consideration of problems dealing with transportation systems as they affect the socio-economic development of cities, regions, and nations; the travel behavior of a populace; the location of economic

activity; the use of land; and the allocation of resources. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5654:

Critical Issues in Transportation

Technological, societal, economic, political, environmental, health, and energy effects on planning, design, operation, and management of the transportation system. Modeling of complex interactions and causal relationships among current issues. Principles of optimization for design and operation of the five basic elements of transportation (vehicles, networks, terminals, controls, and system administration). Problem definition, objectives identification, model development, alternatives generation and evaluation, and reasoning process for transportation investment. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5660:

Trans Risk, Reliab & Security

Transportation risk assessment and computation; evacuation modeling; reliability analysis; infrastructure interdependency analysis; network impact assessment. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 2224 (UG), (STAT 3704 (UG) OR STAT 4604 (UG) OR STAT 4705 (UG))

Corequisite(s):

CEE 5670:

Applied Traffic Engr Analysis

Definition of traffic engineering and theory of traffic engineering. Evaluation and identification of traffic engineering problems and development of solutions. Application of theory to real-world problems using intersection design and control, analysis of capacity and level of service for freeways and arterials, traffic signal design and optimization, geometric design, highway and intersection simulation. Pre-requisite:

Graduate Standing
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CEE 5674:

Advanced Pavement Design

Methods used to characterize, stabilize, and specify pavement materials. Methods for rigid and flexible highway and airport pavement design and analysis. Load equivalence factor and specific design considerations related to environment and traffic characteristics. Pavement overlay design. Software for pavement design and analysis using various models. II
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): (CEE 3684 (UG), CEE 4664 (UG)) OR (CEE 3684, CEE 4664)
Corequisite(s):

CEE 5684:

Rehabilitation of Transportation Structures

Identification of maintenance and rehabilitation needs for transportation structures such as bridges and pavements. Cost effective maintenance and rehabilitation methods. Consideration of bridge and pavement management systems. I
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

CEE 5694:

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. Graduate standing required.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5704:

Environmental Chemistry Laboratory

Laboratory course in support of 5104, Environmental Chemistry, allowing students to perform experiments related to natural environmental processes, including biological oxygen consumption, complexation, and carbonate equilibria. Consideration of laboratory procedures used to investigate and assess environmentally related materials and their contaminants.
Credit Hour(s): 1
Lecture Hour(s):
Instruction Type(s): Lab
Instruction Type(s): Lab
Prerequisite(s):
Corequisite(s): CEE 5104

CEE 5714:

Surface Water Quality Modeling

Use, analysis, and development of water quality models for lakes, rivers, and estuaries. Emphasis on model calibration, verification, and post-audit analysis. Lab portion will develop and apply a eutrophication model for an estuary using existing data.
Credit Hour(s): 0 OR 3
Lecture Hour(s): 0 OR 2
Instruction Type(s): Lab, Lecture
Instruction Type(s): Lab, Lecture
Prerequisite(s):
Corequisite(s):

CEE 5724:

Environmental Monitoring and Sampling

Experimental design and sampling techniques for environmental analysis, including environmental monitoring techniques and statistical principles for planning monitoring locations and frequencies at environmental sites such as landfills, rivers, lakes, and the atmosphere. Development of monitoring strategy; examination of sampling techniques for various sample types. I
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): STAT 2004 (UG) OR STAT 2004
Corequisite(s): CEE 5104

CEE 5734:**Urban Hydrology and Stormwater Management**

Development of methods and numerical models for computing surface runoff from developing watersheds; hydraulics of combined sewer systems; urban non-point source pollutant load calculations and best-management practices; control strategies for regional stormwater management; detention basin design for control of urban floods and non-point source pollutants. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4304 (UG) OR CEE 4304

Corequisite(s):

CEE 5744:**Topics in Structural Steel Design**

Calculation of stresses in steel members. Overall-local buckling interaction. Design of singly symmetrical and unsymmetrical columns and topics on flexural design, design of plate girders, bracing design, and design of framing connections. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3434 (UG) OR CEE 3434

Corequisite(s):

CEE 5754:**Pavement and Bridge Infrastructure Management Systems**

Management concepts used in civil infrastructure; planning, design, construction, maintenance, and rehabilitation of bridge and highway systems. Prioritization, optimization, and decision-making techniques. Life-cycle-cost prediction.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3684 (UG), CEE 4664 (UG)) OR (CEE 3684, CEE 4664)

Corequisite(s):

CEE 5764:**Asphalt Technology**

Origin, types and properties of bituminous materials and their use in civil engineering. Asphalt rheology. Theory behind technological processes and procedures for hot-mix asphalt including design philosophy,

performance, and durability. Modern construction with bituminous materials; special mixtures, recycling, and additives. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CEE 4614 (UG) OR CEE 4614

Corequisite(s):

CEE 5774:**Hazardous Waste Management**

Review of regulatory framework governing hazardous waste management. Characteristics of hazardous wastes. Fundamental physical, chemical, and biological principles applied to the design of treatment processes. Risk management. Case studies. Design project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s): CEE 5104

CEE 5794:**Environmental Engineering Principles**

Examines the basic physical, chemical, and microbiological principles that provide the foundation for environmental engineering. Illustrates how these principles are applied to solve a wide range of environmental problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s): CEE 5104

CEE 5804:**Engineering Ethics and the Public**

Moral obligations of engineers and scientists toward the publics they serve; responsible conduct of research; responsible conduct of practice; the responsibilities and risks of witnessing wrongdoing; the value of non-expert knowledge claims and the importance of listening to public stakeholders. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CEE 5944:

Seminar

Review and discussion of current literature, research, and consulting activities by student, faculty, and guest speakers. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

CEE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CEE 6014:

Project and Company Management

Study of the management of a construction project and a construction company. Project management includes finances, cash flows, cost control, project organization, and project planning. Company management includes company organization incorporation structure, procedures, finance, insurances, accounting, and operation. Case studies are emphasized. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 6104:

Advanced Environmental Chemistry

Advanced theories and practices in environmental engineering with special emphasis on inorganic aspects of water chemistry; application of water chemistry fundamentals for the description of aquatic systems. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 5104 (UG) OR CHEM 3616 (UG)) OR (CEE 5104 OR CHEM 3616)

Corequisite(s):

CEE 6114:

Advanced Topics in Air Quality Engineering

Review and critique of current research. Emissions, transport, transformation, and fate of gases and particles in the atmosphere. May be repeated with different topic content for a maximum of 3 credits.

Credit Hour(s): 1

307 Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5154

Corequisite(s):

CEE 6404:

Dynamics of Structures

Formulation of equations of motion by the finite element method.

Solution by mode superposition and direct methods. Earthquake

analysis and nonlinear analysis. Application to skeletal and plate

structures. Development of computer programs and use of commercial

programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 5414 (UG), ESM 4074 (UG)) OR (CEE 5414,

ESM 4074)

Corequisite(s):

CEE 6424:

Advanced Prestressed Concrete

Behavior and design of prestressed slabs, bridges, and precast building

systems. Continuous prestressing; load-balancing method for slabs;

torsion and shear; connections for precast members; partial

prestressing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4424 (UG) OR CEE 4424

Corequisite(s):

CEE 6434:

Advanced Steel Design

Advanced topics of current interest in structural steel design research as

given by recent publications and informal reports. In-depth study of

selected projects. May be repeated. 12 credits of 5000-level courses in

structures or solid mechanics required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4434 (UG) OR CEE 4434

Corequisite(s):

CEE 6504:

Theoretical Soil Mechanics

Constitutive Laws for Soils, nonlinear elastic and plastic models.

Consolidation, layered systems, sand drains, approximate three-

dimensional theories, and Biot's poro-elastic formulation. Plastic

equilibrium in soils Sokolovski's method of characteristics, applications

to earth pressure, bearing capacity, and slope stability problems.

Analysis of machine foundation problems, elastic waves through soils,

dynamic properties of soils. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5514 (UG) OR CEE 5514

Corequisite(s):

CEE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

COMPUTER ENGINEERING

Luke Lester, Head

Emeriti Faculty: Gary Brown; William Davis; Arun Phadke; Timothy Pratt;

Krishnan Ramu; James Thorp;

Professors: Peter Athanas; Aloysius Beex; Dushan Boroyevich; Robert

Broadwater; Richard Buehrer; C Clauer; Gregory Earle; Dong Ha; Yiwei Hou;

Michael Hsiao; Mark Jones; Jih Lai; Fred Lee; Luke Lester; Thomas Martin; Scott

Midkiff; Lamine Mili; Khai Ngo; Mariusz Orlowski; Paul Plassmann; Ting Chung

Poon; Saifur Rahman; Sanjay Raman; Binoy Ravindran; Jeffrey Reed; Sedki Riad;

Ahmad Safaai-Jazi; Wayne Scales; Sandeep Shukla; Luiz Silva; Daniel Stilwell;

William Tranter; Joseph Tront; Yue Wang; Anbo Wang;

Associate Professors: Amos Abbott; Masoud Agah; Scott Bailey; Joseph Baker; William Baumann; Rolando Burgos; Virgilio Centeno; Thomas Clancy; Jaime De La Reelopez; Steven Ellingson; Louis Guido; Mantu Hudait; Douglas Lindner; Allen MacKenzie; Leyla Nazhandali; Willem Odenaal; Jung-Min Park; Cameron Patterson; JoAnn Paul; John Ruohoniemi; Patrick Schaumont; Kwa Sur Tam; Chris Wyatt; Jianhua Xuan; Yaling Yang;

Assistant Professors: Dhruv Batra; Harpreet Singh Dhillon; Kwang-Jin Koh; Qiang Li; Majid Manteghi; Rosalyn Moran; Devi Parikh; Walid Saad; Chao Wang; Yong Xu; Guoqiang Yu; Haibo Zeng; Yizheng Zhu;

Grant A. Dove Professor: Yue Wang;

Bradley Distinguished Professor of Electromagnetics: Gary Brown;

Hugh P and Ethel C Kelly Professor: James Thorp;

Bradley Professor of Communications: William Tranter;

Willis Worcester Professor: Jeffrey Reed;

University Distinguished Professor: Fred Lee; Arun Phadke;

Clayton Ayre Professor: Anbo Wang;

American Electric Power Professor: Dushan Boroyevich;

Joseph R. Loring Professor: Saifur Rahman;

Virginia Microelectronics Consortium Chair: Mariusz Orlowski;

Graduate Admissions: vt.ece.gradadm@vt.edu

Graduate Counseling: vt.ece.gradadv@vt.edu

NCR Graduate Coordinator: cdrobi@vt.edu

Student Handbook: <http://www.ece.vt.edu/gradman/manual.php>

The Harry Lynde Bradley Department of Electrical and Computer Engineering offers graduate degree programs leading to the Master of Engineering (M.Eng.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) in electrical engineering and computer engineering. All degree programs are offered through the Blacksburg campus as well as extended campus consortia (National Capital Region, Northern Virginia Center, Falls Church, Virginia; Central; Hampton Roads; Western, and VT-MENA through Alexandria and Cairo, Egypt). For the master's degree, each plan of study, developed by the student in consultation with his or her faculty advisor, must contain a limited number of core courses. The M.S. degree program requires a thesis. The M.Eng. is a non-thesis degree program and is especially suitable for part-time graduate students employed as engineers by industry and government agencies. The Ph.D. degree program is research-oriented. Applicants applying for these degrees program must have an earned Master's degree in CPE, EE or related field. A direct-Ph.D. option is available for students without an earned Master's degree. These students will earn a Master of Science, Thesis, or Master of Science, Non-Thesis, degree in addition to the Ph.D. The Bradley Department of Electrical and Computer Engineering's current enrollment is approximately 525 students. Out of the enrolled students, approximately 95% of our full-time Ph.D. students are funded and approximately 75% of our full-time Master's student are funded. Funding is available in three ways: Graduate Teaching Assistantships - Awarded by the department Graduate Research Assistantships - Awarded by individual faculty Fellowships - Awarded by the department to the very top applicants to the program. Of the fellowships awarded by the department, the Bradley Fellowship is the highest honor bestowed on ECE Ph.D. students and is restricted to U.S. citizens only.

SPECIAL FACILITIES

Well-equipped research facilities, labs, and centers are available within the different research areas. For more information, [click here](#).

DEGREES OFFERED

MEng Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Blacksburg, Richmond)

TOEFL

Paper: (590.0)

Computer: (243.0)

iBT: (96.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Writing (4.5)

IELTS

General: Band (7.5)

32 credit hours 27 credit hours of course work 3 credit hours of project and report 2 credit hours of seminar The ECE Graduate Student Policy Manual gives detailed information pertaining to degree requirements.

Degree Concentrations:

Research Areas

The outstanding ECE faculty is world-renowned for teaching and research. Students can select an area of research from the following Computer Engineering areas available through the Bradley Department of Electrical and Computer Engineering: Computer Systems Networking Software and Machine Intelligence VLSI and Design Automation

MS Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Blacksburg, Richmond)

TOEFL

Paper: (590.0)

Computer: (243.0)

iBT: (96.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Writing (4.5)

IELTS

General: Band (7.5)

32 credit hours 21 credit hours of course work 9 credit hours of research and thesis 2 credit hours of seminar The ECE Graduate Student Policy Manual gives detailed information pertaining to degree requirements.

Degree Concentrations:

Research Areas

The outstanding ECE faculty is world-renowned for teaching and

research. Students can select an area of research from the following Computer Engineering areas available through the Bradley Department of Electrical and Computer Engineering: Computer Systems Networking Software and Machine Intelligence VLSI and Design Automation

PhD Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Blacksburg, Richmond)

TOEFL

Paper: (590.0)

iBT: (96.0)

GRE

General: Verbal (153.0), Quantitative (157.0), Analytical (4.5)

Regular PhD Requirements (for students with an earned Masters):92 credit hours 30 credit hours of course work 60 credit hours of research and thesis 2 credit hours of seminar Direct-PhD Requirements (for students with only an earned Bachelors):MS, Thesis and PhD - 92 credit hours 21 credit hours of coursework for MS (all transfer to PhD) 9 additional credit hours of coursework for PhD 9 hours of research and thesis for MS 60 credit hours of research and dissertation for PhD 2 credit of seminar that will count for both MS and PhD Ms, Non-Thesis and PhD - 92 credit hours 30 credit hours of coursework for MS (all transfer to PhD) 60 credit hours of research and dissertation for PhD 2 credit of seminar that will count for both MS and PhD The ECE Graduate Student Policy Manual gives detailed information pertaining to degree requirements.

GRADUATE COURSES (ECE)

ECE 5015:

Network Synthesis and Design

Positive real and bounded real concepts. Synthesis of two-element-kind lumped networks. Scattering description. Synthesis of RLC impedances. Approximation methods for lumped filters. Synthesis of microwave filters. Synthesis of switched-capacitor networks. Design techniques for active RC filters modeled on classical structures. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4205

Corequisite(s):

ECE 5016:

Network Synthesis and Design

Positive real and bounded real concepts. Synthesis of two-element-kind lumped networks. Scattering description. Synthesis of RLC impedances. Approximation methods for lumped filters. Synthesis of microwave filters.

Synthesis of switched-capacitor networks. Design techniques for active RC filters modeled on classical structures. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4205

Corequisite(s):

ECE 5104:

RF & Microwave Engineering and Applications

A review of basic electromagnetics. Transmission lines, waveguides, microstrip lines, striplines. Microwave networks and impedance matching, Smith chart, S-Matrix, ABCD matrix, transformers. Microwave filters. Active RF components. Microwave amplifier design. Microwave systems. Microwave Integrated Circuits (MIC). RF Microelectromechanical System (MEMS) components. RF components for wireless systems. RF components for Ultra Wideband (UWB) systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4104 (UG) OR ECE 4104

Corequisite(s):

ECE 5104G:

Advanced Microwave and RF Engineering

Passive and active RF 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. Active RF components. Microwave amplifier design. Microwave Integrated Circuits (MIC). RF Microelectromechanical System (MEMS) components. Microwave systems. RF components for wireless systems. RF components for Ultra Wide band (UWB) systems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5105:

Electromagnetic Waves

problems. 5105: Fundamental concepts associated with elementary plane wave theory and boundary value problems with applications to half-space reflection problems; fundamental theorems. 5106: Analytical techniques (Green's theory, modal analysis, integral equations, etc.) applied to setting up, approximating, and solving radiation, unguided, and guided wave propagation, and scattering by medium discontinuities in open and closed geometries. Graduate standing required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 3106 (UG) OR ECE 3106

Corequisite(s):

ECE 5106:

Electromagnetic Waves

Maxwell's electromagnetic field theory and its applications to engineering problems. 5105: Fundamental concepts associated with elementary plane wave theory and boundary value problems with applications to half-space reflection problems; fundamental theorems. 5106: Analytical techniques (Green's theory, modal analysis, integral equations, etc.) applied to setting up, approximating, and solving radiation, unguided, and guided wave propagation, and scattering by medium discontinuities in open and closed geometries. Graduate standing required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 3106 (UG) OR ECE 3106 (UG)

Corequisite(s):

ECE 5134G:

Advanced Fiber Optics and Applications

Theory of optical fiber waveguide propagation and design applications in communication and sensing systems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5144:

Introduction to Electro-Optics

Physical optics, wave propagation in inhomogeneous media, acousto-optic and electro-optic effects and their applications in intensity

modulation and phase modulation of laser beams. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 3106 (UG), ECE 3614 (UG)) OR (ECE 3106, ECE 3614)

Corequisite(s):

ECE 5160:

Introduction to Space Plasmas

Underlying physical processes in the space environment medium in terms of plasma physics and electrodynamics. Single particle motion, fluid and kinetic theory of plasmas, plasma waves and instabilities, diffusion and resistivity, and a brief introduction to nonlinear effects. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5164:

Introduction to Space Science I: The Solar Wind and Magnetosphere

Describes the space environment from the sun to the earth's upper atmosphere. Fundamental concepts in space plasma physics will be presented, as needed, throughout the course. Numerous examples of observations and data will be utilized to illustrate the environment and its dynamic variability. An emphasis will be placed on the practical impacts of this environment and its dynamic variability. An emphasis will be placed on the practical impacts of this environment (space weather) on modern technologies such as solid state devices, satellite technology, communication and global navigation systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 3106 (UG) OR ECE 3106

Corequisite(s): ECE 5105

ECE 5200 (MSE 5200):

Semiconductor Alloys and Heterstructures

Advanced treatment of semiconductor materials with an emphasis on binary compounds, ternary and quaternary alloys, and strained-layer

structures. Topics include crystal structure; lattice vibrations and phonons; energy band structure; equilibrium and non-equilibrium carrier distributions; electron and hole transport via diffusion and drift; and carrier generation and recombination mechanisms. Graduate standing required in the College of Engineering or College of Science.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 3204 (UG) OR ECE 4214 (UG) OR PHYS 3455 (UG) OR ECE 4214 OR MSE 3204 OR PHYS 3455

Corequisite(s):

ECE 5204:

Power Semiconductor Devices

Characteristics, fabrication, and application of power semiconductor devices, which may include p-i-n and Schottky diodes, insulated gate bipolar transistors, field effect transistors, and thyristors. Effect of semiconductor material, device structure, and current injection levels on device performance. Device drive requirements and power circuit interaction. Implementation of power devices using wide band gap semiconductors such as silicon carbide and gallium nitride.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5200

Corequisite(s):

ECE 5205:

Basic Semiconductor Devices

Description of the performance characteristics and limitations of basic semiconductor electronic devices in terms of the properties of semiconductor materials and device structure. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5206:

Basic Semiconductor Devices

Description of the performance characteristics and limitations of basic semiconductor electronic devices in terms of the properties of semiconductor materials and device structure. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5210:

MicroElectroMechanical Systems: From Fabrication to Application

MicroElectroMechanical Systems (MEMS) are "very-small systems" or "systems made of very small components". The course focuses on the design, fabrication, and application of microsystems providing a unique opportunity for interdisciplinary interactions. The course consists of lectures, readings from the current literature, discussion by students, and team-work projects. The major topics covers are: materials in MEMS; microfabrication techniques; sensing and actuating mechanisms; wafer-level packaging; and case-study of some MEMS-based devices and lab-on-a-chip systems. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4234 (UG) OR ECE 4234 OR BCHM 4124 (UG) OR BCHM 4124 OR CHE 4114 (UG) OR CHE 4114 OR CHEM 4124 (UG) OR CHEM 4124 OR ESM 4014 (UG) OR ESM 4014 OR ESM 4024 (UG) OR ESM 4024 OR ME 4304 (UG) OR ME 4304 OR ME 4404 (UG) OR ME 4404 OR MSE 4254 (UG) OR MSE 4254 OR MSE 4354 (UG) OR MSE 4354

Corequisite(s):

ECE 5214:

Phase-locked Loops: Theory and Practice

Fundamental theory and design concepts of frequency synchronization techniques. Emphasis is on phase-locked loops and applications in communications for frequency synthesis, tracking, and demodulation. Laboratory investigates fundamental principles of operation with a final project to develop specific aspects of a loop in detail. Alternate year course.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405

Corequisite(s):

ECE 5220:

Radio Frequency Integrated Circuit Technology and Design

312 Integrated circuit (IC) implementation of RF circuits for wireless

communications applications. Transceiver architectures for current wireless communications standards; active/passive device technologies for RFIC implementations; low noise amplifiers; mixers; frequency sources; power amplifiers; single-chip radios; and RFIC packaging and testing. Case studies of modern RFIC chip sets for current wireless communications standards are examined. The course involves circuit design at the IC level; modern RF/microwave CAD software will be used in conjunction with the course. Design of a wireless transceiver functional block component RFIC chip. Alternate years. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 3204 (UG), ECE 3614 (UG)), (ECE 4605 (UG) OR ECE 4104 (UG)) OR (ECE 3204, ECE 3614), (ECE 4605 OR ECE 4104)

Corequisite(s):

ECE 5224:

Non-Linear Communication Circuits

Advanced methods of analysis and design of communication circuits with emphasis on nonlinear effects and filtering. Nonlinear device models and their use in the design of oscillators and mixers at HF through UHF frequencies. The design of power amplifiers. I. Alternate years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4605 (UG) OR ECE 4605

Corequisite(s):

ECE 5234:

Emi and Noise Reduction Techniques and Filter Design

Theory and practice of E.M. noise coupling; Techniques for noise reduction: shielding, grounding and filtering. Measurement of EMI to comply with government regulation. EMI problems and solutions to switching power supply applications. Design of EMI filter. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4205 (UG) OR ECE 4224 OR ECE 4205

Corequisite(s):

ECE 5235G:

ADV Electronic Packaging

Design issues such as electrical, electromagnetic, thermal, mechanical, and thermomechanical, are covered at the lower levels of packaging hierarchy. Materials and process selection guidelines are discussed for the manufacturing and reliability of chip carriers, multichip and hybrid modules. Theoretical bases for design methodology and package reliability. Solid modeling for electrical and thermal designs from chip to board. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5236G:

ADV Electronic Packaging

System-level package design issues to meet application requirements are introduced and modeling tools for analyzing electronic packages are applied. Materials and process selection guidelines are discussed for the manufacturing and reliability of packaged electronic products.

Application of theoretical principles to analysis designs. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5240G:

Adv Semiconductor Proc Lab

Design, layout, fabricate, and characterize microelectronic devices.

Analyze test results to verify performance to the predetermined specifications. Participate on a team project in which they will develop processes used to fabricate more advanced devices and/or circuits.

Required oral and written reports. May not be taken if credit has been previously earned for ECE 4244.

Credit Hour(s): 3

Lecture Hour(s): 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ECE 4234 (UG) OR ECE 4234 OR MSE 4234 (UG) OR MSE 4234

Corequisite(s):

Advanced Power Conversion Techniques

High-frequency resonant, quasi-resonant, and multi-resonant power conversion techniques; zero-voltage and zero-current switching techniques in pulse-width modulation converters and inverters. Pulse-width modulation and frequency modulation; non-linear analysis techniques for resonant and soft-switching converters and inverters. Power factor correction rectifiers and distributed power systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5254:

Power Converter Modeling and Control

Nonlinear modeling of power conversion circuit using discrete and average techniques analysis and design of voltage mode and current mode control; parallel module operation and system interactions; distributed power systems; time domain simulation and frequency domain measurement techniques. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5260:

Power Electronics System Integration

A broad overview of advanced power electronics technologies with an emphasis on multi-disciplinary aspects of integrated design. Investigation of relationships between system application requirements and technological challenges in circuit topologies, power semiconductor devices, sensing and control, integrated packaging, and thermal management, and their impact on the system reliability and cost. Introduction to the concept of integrated power electronics modules and their application in distributed power systems and motor drives. The course is organized as a series of seminar lectures jointly taught by leading researchers from several universities and industry, via distance access.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5274:

Modeling and Control of Three-Phase PWM Converters

Power conversion principles for three-phase pulse-width modulation techniques, control and converters. Development of averaged models of three-phase rectifiers and inverters in stationary and rotating coordinates. Small-signal models in rotating coordinates and control design. Introduction of switching state vectors and different modulation schemes. Three-phase inverter and rectifier applications. Parallel and multi-level three-phase converters. Alternate years. Prerequisite or equivalent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5314:

Power System Operation and Control

A course dealing with modern power system operational and control problems and solution techniques. State estimation, contingency analysis, load-frequency control, and automatic generation control. Load flow analysis and external equivalents for steady-state operations. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4334 (UG) OR ECE 4334

Corequisite(s):

ECE 5324:

Power System Planning

A study of generation planning, bulk power supply systems, production costing analysis, and load forecasting. Dispersed generation. Electric power system reliability and stability. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4334 (UG) OR ECE 4334

Corequisite(s):

ECE 5334:

Electric Machines and Transients

Development of inductances, flux linkages, voltage equations, linear transformations, continuous simulation techniques, and machine models.

Transients on transmission lines, transformers, and machines. Arcing and restriking phenomena. Lightning arresters and insulation coordination. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4314 (UG) OR ECE 4314

Corequisite(s):

ECE 5364:

Electric Energy and Environmental Systems

Role of electricity from fossil and nuclear fuels, and renewable resources. Impact of high voltage transmission lines. Health effects of electricity generation. Assessment of cogeneration cycles and demand side management. Emission control in the US electric utility industry. Evaluation of uncertainties in quantifying emissions impacts. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5374G:

Adv 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. System level cost benefit analysis. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5504 (CS 5504):

Computer Architecture

Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, programming and interconnection network properties, principles of scaleable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4504 (UG) OR ECE 4504

Corequisite(s):

ECE 5505:

Testing and Fault-tolerant Computing

Various topics on digital circuit testing and verification. 5505: digital circuit testing including simulation, test pattern generation, design for testability, built-in-self-test, and diagnosis. Graduate standing in ECE is required. 5506: circuit verification including two-level and multi-level circuit verification, sequential circuit verification, model-checking simulation-based verification, and ATPG-based verification. Graduate standing in ECE required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECPE 4505

Corequisite(s):

ECE 5506:

Testing and Fault-tolerant Computing

Various topics on digital circuit testing and verification. 5505: digital circuit testing including simulation, test pattern generation, design for testability, built-in-self-test, and diagnosis. 5506: circuit verification including two-level and multi-level circuit verification, sequential circuit verification, model-checking simulation-based verification, and ATPG-based verification. Graduate standing in ECE required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECPE 4505

Corequisite(s):

ECE 5510 (CS 5510):

Multiprocessor Programming

Principle and practice of multiprocessor programming. Illustration of multiprocessor programming principles through the classical mutual exclusion problem, correctness properties of concurrency (e.g., linearizability), shared memory properties (e.g. register constructions), and synchronization primitives for implementing concurrent data structures (e.g., consensus protocols). Illustration of multiprocessor programming practice through programming patterns such as spin locks, monitor locks, the work-stealing paradigm and barriers. Discussion of

concurrent data structures (e.g., concurrent linked lists, queues, stacks, hash maps, skiplists) through synchronization patterns ranging from coarse-grained locking to fine-grained locking to lock-free structures, atomic synchronization primitives, elimination, and transactional memory. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4534 OR ECE 4550

Corequisite(s):

ECE 5514:

Design of Systems on a Chip

Current state of the art in the system-level design of Systems on a Chip.

The focus is in hardware, scheduling, and applications at the highest levels of design. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4514 (UG) OR ECE 4514

Corequisite(s):

ECE 5515:

Computer and Network Architectures

5515: Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, program and network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors. 5516: Local area networks, wide area networks, and internets. Protocols and the ISO Open Systems Interconnect reference model. Design, analysis, and performance evaluation. Emphasis on data link, network, and transport protocols. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4504 OR CS 4504

Corequisite(s):

ECE 5516:

Computer and Network Architectures

5515: Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, program and network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection

networks, SIMD and MIMD processors. 5516: Local area networks, wide area networks, and internets. Protocols and the ISO Open Systems Interconnect reference model. Design, analysis, and performance evaluation. Emphasis on data link, network, and transport protocols. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4504 OR CS 4504

Corequisite(s):

ECE 5520:

Secure Hardware Design

Design and implementation of secure hardware at multiple levels of abstractions, covering cryptographic hardware primitives, cryptographic hardware primitives, cryptographic modules using passive attacks, active attacks, and cryptanalytic techniques. Countermeasures against reverse engineering. The course uses case studies and literature surveys to reflect on the state-of-the-art in secure hardware implementation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4514 (UG) OR ECE 4514

Corequisite(s):

ECE 5524:

Pattern Recognition

Computational methods for the identification and classification of objects. Feature extraction, feature-space representation, distance and similarity measures, decision rules. Supervised and unsupervised learning. Statistical pattern recognition: multivariate random variables; Bayes and minimum-risk decision theory; probability of error; feature reduction and principal components analysis; parametric and nonparametric methods; clustering; hierarchical systems. Syntactic pattern recognition: review of automata and language theory; shape descriptors; syntactic recognition systems; grammatical inference and learning. Artificial neural networks as recognition systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

ECE 5530:

Configurable Computing

The design and implementation of high-performance computing machinery using configurable computing technology is studied. Contemporary computing methodologies are investigated, modeled, and constructed in laboratory exercises. Computational solutions are implemented by using field programmable gate arrays and adaptive computing devices.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4514 (UG), ECE 5504 (UG)) OR (ECE 4514, ECE 5504)

Corequisite(s):

ECE 5534:

Electronic Design Automation

This course introduces graduate students to the various design automation artifacts, algorithms, and methodologies. It includes system level design languages, abstractions, models of computation, high level synthesis, modeling and model transformations, and simulation based validation. The course deals with state of the art design practices. It requires a solid back-ground in computer architecture, digital design, and proficiency in programming and modeling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4514 (UG) OR ECE 4514

Corequisite(s):

ECE 5544:

Coding Theory

Use of codes to improve the reliability of transmission over noisy channels. Algebraic structure of codes. Includes error detecting and correcting codes. BCH Codes, Reed Solomon Codes, and convolutional codes and codes for checking arithmetic operations. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 4714 (UG), MATH 4124 (UG)) OR (STAT 4714, MATH 4124)

Corequisite(s):

ECE 5545:

Advanced VLSI Design

Advanced concepts in CMOS-based digital system are studied. The

topics include implementation of special purpose structures for complex digital systems, automation and verification of the design process, and design for testability (5545); and design techniques for low-power design, power dissipation estimation, and application of low-power techniques in the different levels of the design hierarchy (5546).

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4540 (UG) OR ECE 4540

Corequisite(s):

ECE 5546:

Advanced VLSI Design

Advanced concepts in CMOS-based digital system design are studied.

The topics include implementation of special purpose structures for complex digital systems, automation and verification of the design process, and design for testability (5545); and design techniques for low-power techniques in the different levels of the design hierarchy (5546) design, power dissipation estimation, and application of low-power techniques in the different levels of the design hierarchy (5546).

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4540 (UG) OR ECE 4540

Corequisite(s):

ECE 5550G:

Advanced Real Time Systems

Introduction to real-time systems, real-time scheduling including multiprocessor scheduling, real-time operating systems (kernels), real-time communication, real-time programming languages, reliability and fault-tolerance, and real-time system requirements and design methods. Design, analysis, and implementation of real-time kernel mechanisms and real-time applications using kernels such as Linux and programming languages such as C (with POSIX primitives) and real-time Java. Prerequisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5554:

Computer Vision Sys

Gives a critical examination of current theories of computer vision. Explores both image analysis and scene analysis methods with the emphasis being given to scene analysis techniques. Emphasis is placed on the strategies that can be used rather than upon particular operators. Gives the design trade-offs associated with the various strategies. Draws analogies between computer vision techniques and the operations that are seemingly performed in human vision.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): CS 5534, CS 5814

ECE 5560 (CS 5560):

Network and Computer Security

Introduces both fundamental security principles as well as real-world applications of network and computer security. Covers a wide range of topics including authorization and access control, basic cryptography, authentication systems, e-commerce security, sensor network security, and legal and ethical issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4564 (UG) OR ECE 4564 OR CS 4254 (UG) OR CS 4254 OR ECE 5565 OR CS 5565 (UG)

Corequisite(s):

ECE 5564:

Wearable and Ubiquitous Computing

Issues in the design and use of wearable and ubiquitous computing systems. Topics covered include current research issues in system-level low power design, input/output devices, location and context-awareness, and networking. Students are expected to design, implement, and evaluate a wearable computing device or application.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4534 (UG) OR ECE 4550 (UG) OR ECE 4534 OR ECE 4550

Corequisite(s):

ECE 5565 (CS 5565):

Network Architecture and Protocols

5565: Principles and concepts of networking and protocols, with

emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.

5566: Performance evaluation, design, and management of networks.

Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols.

Network management architectures and protocols. Graduate standing in EE, ECE, CS, or IT is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

ECE 5566 (CS 5566):

Network Architecture and Protocols

5565: Principles and concepts of networking and protocols, with emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.

5566: Performance evaluation, design, and management of networks.

Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols.

Network management architectures and protocols. Graduate standing in EE, ECE, CS or IT is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5565 (UG) OR ECE 5565

Corequisite(s):

ECE 5574G:

ADV Software Development CAE

Computer-aided engineering software that address the hierarchy of engineering analysis, design, and decision evaluation is developed with state-of-the-art computer tools. Linear graph theory is applied to the modeling of physical networks. Operator overloading, dynamic polymorphism, graphical user interfaces, dynamic link libraries, and multiple threaded programs are considered. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5575:

Object-Oriented Software Devel

Use cases, class models, state models, interaction modeling, constraint modeling, message design, and concurrent and real-time systems.

Students develop analysis documentation for an Engineering related project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4574 (UG) OR ECE 4574

Corequisite(s):

ECE 5576:

Object-Oriented Software Devel

Object-oriented design, including both logical and physical design. In logical design, rules related to class interfaces, containment, inheritance, and associations are covered along with design patterns. Physical design addresses components, leveled designs, and the application of generic programming concepts in design. Students develop design documentation for an engineering software project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4574 (UG) OR ECE 4574

Corequisite(s):

ECE 5585:

IT Security and Trust

Fundamental Internet and computer security principles and applications; legal and privacy issues, risk analysis, attack techniques, intrusion detection concepts, basic computer forensics, and system and application security hardening techniques. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5586:

IT Security and Trust

Advanced security and trust concepts and implementation in wired and wireless computer networks and computer systems; malware defenses, impact of channel fragility, node mobility, cooperative functionality, and resource constraints on security and trust at the different layers of the Internet protocol stack.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5585

Corequisite(s):

ECE 5604:

Computer-Aided Design and Analysis of Communication Systems

Simulation techniques for communication systems operating in random environments. Simulation models for stochastic signals and system components including coders, decoders, modulators, non-linear amplifiers, bit and carrier synchronizers, equalizers and receivers. Techniques for modeling time-varying channels. Monte Carlo simulation, semi-analytic simulation and variance reduction techniques applied to the analysis, design and performance evaluation of communication systems. Programming experience required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4624 (UG), ECE 4634 (UG), STAT 4714 (UG)) OR (ECE 4624, ECE 4634, STAT 4714)

Corequisite(s): ECE 5605

ECE 5605 (BMES 5525):

Stochastic Signals and Systems

Engineering applications of probability theory, random variables and random processes. Time and frequency response of linear systems to random inputs using both classical transform and modern state space techniques. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

ECE 5606:

Stochastic Signals and Systems

to Gaussian and non-Gaussian random processes. Introduction to signal detection theory and optimal filtering (estimation) techniques. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5605 (UG) OR ECE 5605

Corequisite(s):

ECE 5634:

Information Theory

Transmission of information over noisy channels. Measures of information and transmission channel capacity. Use of codes to improve the reliability of such transmission. Mathematical theory of information.

Transmission at rates above channel capacity. Includes linear codes, error detecting and correcting codes, Hamming codes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 4714 (UG), ECE 4634 (UG), ECE 5605 (UG))

OR (STAT 4714, ECE 4634, ECE 5604)

Corequisite(s):

ECE 5635:

Radar Systems Analysis and Design

5635: Theory and practice of radar systems used for detection, tracking, and location of targets. Covers measurement of range and velocity, pulse compression, design of radar transmitters, receivers, and antennas. 5636: Performance analysis of modern radar signal processing techniques. Topics include radar signal detection theory and optimal receiver analysis, target parameter estimation, pulse compression techniques, clutter reduction, and tracking. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5636:

Radar Systems Analysis and Design

5635: Theory and practice of radar systems used for detection, tracking, and location of targets. Covers measurement of range and velocity, pulse compression, design of radar transmitters, receivers, and antennas. 5636: Performance analysis of modern radar signal processing techniques. Topics include radar signal detection theory and

optimal receiver analysis, target parameter estimation, pulse compression techniques, clutter reduction, and tracking. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (ECE 5605 (UG), ECE 5655 (UG)) OR (ECE 5605, ECE 5655)

Corequisite(s):

ECE 5654:

Digital Communications II: Advanced Theory and Analysis

Fundamentals of the theory, design, and analysis of modern digital communication systems. Representation of signal in digital form. Design and analysis of digital modulation formats and receivers using signal space techniques. Combining error correction techniques with digital modulation. Viterbi algorithm for maximum likelihood sequence estimation. Equalization and adaptive equalization. Fading channels and diversity techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (ECE 4634 (UG), ECE 5605 (UG)) OR (ECE 4634, ECE 5605)

Corequisite(s):

ECE 5655:

Communication System Design

5655: Physical concepts and practical topics providing tools to calculate carrier-to-noise ratio in communication systems are discussed, including: noise processes, polarization topics, atmospheric propagation, receiver components, antennas, system calculation, and case studies. 5656: Advanced topics in digital satellite communications are discussed. These include multiple access, digital modulation, error correction coding, carrier phase, and symbol timing recovery. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): ECE 5105

ECE 5656:

Communication System Design

5655: Physical concepts and practical topics providing tools to calculate carrier-to-noise ratio in communication systems are discussed, including:

noise processes, polarization topics, atmospheric propagation, receiver components, antennas, system calculation, and case studies. 5656: Advanced topics in digital satellite communications are discussed. These include multiple access, digital modulation, error correction coding, carrier phase, and symbol timing recovery. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4634 (UG) OR ECE 4634

Corequisite(s):

ECE 5660:

Spread Spectrum Communications

Major topics include: direct sequence and frequency hopping methods, synchronization, resistance to jamming, low probability of detection, spreading codes and their generation, system performance, RAKE receivers, Code Division Multiple Access, cellular CDMA applications, wireless LAN applications, as well as commercial and military applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4634 (UG), ECE 5605 (UG)) OR (ECE 4634, ECE 5605)

Corequisite(s):

ECE 5664:

Cellular Radio and Personal Communications

Fundamental theory and design of high capacity wireless communications systems. Topics include trunking, propagation, frequency reuse, modulation, coding, and equalization. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4634 (UG), ECE 5605 (UG)) OR (ECE 4634, ECE 5605)

Corequisite(s):

ECE 5665:

Telecommunications

5665: Basic concepts in electrical engineering. Waveforms, spectra bandwidth. Fourier series and transform. Decibels, SNR, BER. Analog and digital transmission and modulations. Wire and radio links, link budgets, SNR and BER. Pre: Graduate standing. 5666: Analog modulations, AM,

FM. Digital Modulations, ASK, FSK, PSK, QAM. RRC filtering, digital transmissions. Multiplexing, multiple access. Error control, FEC, ARQ. Local area networks. Optical communication systems. Satellite communications, GPS.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5666:

Telecommunications

5665: Basic concepts in electrical engineering. Waveforms, spectra bandwidth. Fourier series and transform. Decibels, SNR, BER. Analog and digital transmissions and modulations. Wire and radio links, link budgets, SNR and BER. Pre: Graduate standing 5666: Analog modulations, AM, FM. Digital Modulations, FSK, PSK, QAM. RRC filtering, digital transmission. Multiplexing, multiple access. Error control, FEC, ARQ. Local area networks. Optical communication systems. Satellite communications, GPS.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5665

Corequisite(s):

ECE 5674:

Software Radios: Modern Radio Engineering

An introduction to software radios, devices that can be programmed to work with a variety of different radios. The course will cover the following topics: software radio architectures, existing software radio efforts, a review of basic principles, an analysis of receiver operation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4624 (UG), ECE 4634 (UG)) OR (ECE 4624, ECE 4634)

Corequisite(s):

ECE 5714:

Robust Estimation and Filtering

An introduction to the analysis and design of maximum likelihood and robust estimators and filters. Maximum likelihood estimation theory: consistency, asymptotic efficiency, sufficiency. Robust estimation theory:

qualitative robustness, breakdown point, influence function, change-of-variance function. Robust estimators: M-estimators, generalized M-estimators, high-breakdown estimators. Robust estimation of ARIMA models; Robust Kalman filter. Long memory processes: Hurst parameter estimation; parameter estimation of fractional ARIMA models.

Applications to image and speech processing, communications, radar systems, and electric power systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5605

Corequisite(s):

ECE 5724:

Neural and Fuzzy Systems

Introduction to various structures of artificial neural networks and fuzzy logic systems, as well as special learning mechanisms such as generalized back-propagation, clustering and genetic algorithms.

Applications will be made to classification problems, binary associative memories, self-organizing maps, and nonlinear system modeling and control including on-line adaptation. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5704 (UG) OR ECE 5704

Corequisite(s):

ECE 5734 (AOE 5734) (ME 5584):

Convex Optimization

Recognizing and solving convex optimization problems. Convex sets, functions, and optimization problems. Least-squares, linear, and quadratic optimization. Geometric and semidefinite programming. Vector optimization. Duality theory. Convex relaxations. Approximation, fitting, and statistical estimation. Geometric problems. Control and trajectory planning. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5744 (AOE 5744) (ME 5544):

Linear Systems Theory

Advanced introduction to the theory of time-varying and time-invariant

linear systems represented by state equations; solutions of linear systems, uniform stability and other stability criteria, uniform observability and controllability, state feedback and observers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 OR ECE 4405 (UG) OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

ECE 5754 (AOE 5754) (ME 5554):

Applied Linear Systems

Develop an applied understanding of state-space representations for linear time invariant multi-input multi-output dynamic systems in both time domain and frequency domain. Introduction to modern state-space control methods; state feedback and output feedback. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 OR ECE 4624 OR ECE 4634 OR ME 4504 OR AOE 4004 OR ECE 4405 (UG) OR ECE 4624 (UG) OR ECE 4634 (UG) OR ME 4504 (UG) OR AOE 4004 (UG)

Corequisite(s):

ECE 5764 (AOE 5764) (ME 5564):

Applied Linear Control

Analysis and design of sampled-data systems, extraction of discrete-time dynamic models from experimental data, and implementation of dynamic compensators on digital processors. In-depth design experience with LQR optimal control and an introduction to Kalman filtering. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5554 OR ME 5544 OR AOE 5744 OR AOE 5754

Corequisite(s):

ECE 5774 (AOE 5774) (ME 5574):

Nonlinear Systems Theory

Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations: existence and uniqueness of solutions;

continuous dependence on parameters; stability of equilibria and stability analysis techniques; input-to-state stability; input-output stability; nonlinear design techniques including input-state and input-output feedback linearization, backstepping, and sliding mode control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

ECE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ECE 5914:

Autonomous Systems Seminar

Weekly technical presentations from local and visiting scholars on current topics related to the theory, design and development, and application of autonomous vehicle systems. Pre-requisite: Graduate

Standing required

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5944:

Seminar

To acquaint graduate students with recent and current research results

and trends and to introduce researchers to students performing important work in Electrical and Computer Engineering. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5964:

Field Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ECE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ECE 6104:

Advanced Topics in Electromagnetics

Advanced topics of current interest in Electromagnetic Engineering. Topics are selected from current technical literature. May be repeated for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s):

ECE 6114:

Advanced Analytical Electromagnetics

This course comprises PhD-level material covering exact and asymptotic analytical techniques for the solution of advanced electromagnetic problems involving wave propagation and scattering by finite and extended media inhomogeneities.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5106 (UG) OR ECE 5106

Corequisite(s):

ECE 6115:

Antenna Theory and Design I,II

6115: Antenna systems and arrays: antennas in systems, antenna synthesis array fundamentals, array excitation and mutual impedance, waveguide slot arrays, microstrip antennas, microstrip elements, microstrip planar and conformal arrays, numerical methods for antenna analysis, Method of Moments and FDTD, antenna measurements, phased arrays. 6116: Reflectors and aperture antennas: aperture theory, analytical and computer-based designs, reflector antenna fundamentals, numerical methods for reflector analysis, general formulation of GO, PO, GTD, PTD and UTD methods, Gaussian beams, reflector optic configurations, prime-symmetric, Gregorian, Cassegrain and prime-offset reflector systems, analysis of strut scattering, aperture blockage, spillover, G/T analysis, measuring and commissioning reflector systems, reflector feed array, focal plane arrays, defocused arrays.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s): null null

ECE 6116:

Antenna Theory and Design I,II

6115: Antenna systems and arrays: antennas in systems, antenna synthesis, array fundamentals, array excitation and mutual impedance, waveguide slot arrays, microstrip antennas, microstrip elements, microstrip planar and conformal arrays, numerical methods for antenna analysis, Method of Moments and FDTD, antenna measurements, phased arrays. 6116: Reflectors and aperture antennas: aperture theory, analytical and computer-based designs, reflector antenna fundamentals, numerical methods for reflector analysis, general formulation of GO, PO, GTD, PTD and UTD methods, Gaussian beams, reflector optic configurations, prime-symmetric, Gregorian, Cassegrain and prime-offset reflector systems, analysis of strut scattering, aperture blockage, spillover, G/T analysis, measuring and commissioning reflector systems, reflector feed array, focal plane arrays, defocused arrays.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s): null null

ECE 6124:

Advanced Numerical Electromagnetics

A thorough coverage of numerical methods for electromagnetics, including topics on the foundations of function theory, Green's functions, mode-matching, and numerical expansion techniques in both the time and frequency domains. Emphasis will be placed on the method of moments and the finite element method, with development of the theoretical foundations of these methods. Alternate year course. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5106 (UG) OR ECE 5106

Corequisite(s):

ECE 6154:

Photonic Devices and Systems

Electromagnetic analysis of guided-wave optical devices and systems, including transmission properties of optical fibers, photonic crystal waveguides, grating structures, and coupled-wave components; soliton propagation in fibers; Erbium-doped and Raman fiber amplifiers; semiconductor light sources and photodetectors; wavelength-division multiplexed systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s):

ECE 6204:

Advanced Topics in Electronics

Advanced topics of current interest in electronics engineering, with particular emphasis on microelectronics. Topics are selected from current technical literature to stress and reflect important potential areas in the electronic field. These topics include multichip modules, electronic packaging, microwave packaging, modeling simulation and evaluation of high speed devices, wideband characterization of electronic materials and multilayer structures, time and frequency domain measurement techniques. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 6214:

Optoelectronic Devices

Principles of light generation and detection, operation, and design of state-of-the art optoelectronic and photonic devices. Advanced treatment of the operating principles of semiconductor optoelectronic devices with direct comparison to experimental data reported in the literature.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5200

Corequisite(s):

ECE 6304:

Advanced Topics in Power

Advanced topics of current interest in Electric Power Engineering. Topics are selected from current technical literature. Certain topics may be repeated. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 6314:

Advanced Instrumentation in Power Systems

Role of advanced instrumentation in monitoring, control and protection applications in power systems. Effects and limitations of instrument transformers, signal conditioning circuits, analog to digital (A/D) converters and Digital Signal Processing (DSP) chips, time synchronization and sampling, output circuits and devices, and communication channels. Fast Fourier Transform (FFT), protection algorithms, phasor and frequency measurements.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5314

Corequisite(s):

ECE 6334:

Computational Methods in Power Engineering

This course is designed to introduce various linear and nonlinear program based optimization algorithms that are specially suited for the design, analysis and operation of electric power systems, power processing devices, machines, and transformers. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5324 (UG) OR ECE 5324

Corequisite(s):

ECE 6364:

Smart Grid Design & Operation

Introduction to smart grid technologies. Operating principles and models of smart grid components, including distributed energy sources and distribution feeder components. Communication infrastructure for smart grid operation. Advanced metering infrastructure and advanced control methods. Demand response and demand management. Distribution feeder analysis. Impact of smart grid component integration on distribution network operation. Smart grid reliability evaluation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5314 OR ECE 5314 (UG)

Corequisite(s):

ECE 6444:

Advanced Topics in Controls

research topics or technical publications. Graduate standing required.

May be repeated.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5404

Corequisite(s):

ECE 6504:

Advanced Topics in Computer Engineering

Advanced topics of current interest in computer engineering which are taken from current research topics and/or technical publications.

Prerequisites at 5000 level dependent on specific topics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 6514:

Applications of Automata Theory to Digital Design

Applications of theory of finite automata, push-down automata, and Turing machines to the design of digital machines. Emphasis will be on the computational capabilities of classes of finite and infinite automata and on the consequences for digital design. Theory of NP-completeness, description of NP complete problems in digital design, and the consequences for design processes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 3504 (UG), MATH 5454 (UG)) OR (ECE 3504, MATH 5454)

Corequisite(s):

ECE 6564 (CS 6564):

Multimedia Networking

This course examines and explores recent advances in multimedia networking technologies. Major topics include multimedia compression and standards, quality of service (QoS) support mechanisms and protocols, performance analysis, network calculus, IP multicasting, Internet multimedia applications, and multimedia transport over wireless networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5565 (UG) OR ECE 5565

Corequisite(s):

ECE 6570:

Advanced Foundations of Networking

This course covers theoretical foundations that are necessary for advanced study of networking. It focuses on algorithm design and optimization techniques that are most commonly used to solve complex networking problems. Major topics include complexity analysis with applications to networking problems, design and proof of approximation algorithms, design of meta-heuristic algorithms, formulation techniques for network optimization, linear and non-linear optimization techniques with applications to networking, design of distributed algorithms with proof of convergence for networks systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5565 (UG) OR CS 5565 (UG) OR ECE 5565 OR CS 5565

Corequisite(s):

ECE 6604:

Advanced Topics in Communications

Advanced topics of current interest in communications, which are taken from publications and industrial information.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5654 OR ECE 5655

Corequisite(s):

ECE 6624:

Spectral Estimation & Modeling

An advanced introduction to the processing and modeling of random discrete-time signals. Random time series, auto- and cross-correlation sequences and their generation, filtering of random sequences, Wiener filters, matched filters, modeling assumption errors, one-step predictors, rational modeling of random sequences, parametric and non-parametric spectral estimation. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

326 Instruction Type(s): Lecture

Prerequisite(s): (ECE 5605 (UG), ECE 4624 (UG)) OR (ECE 5605, ECE 4624)

Corequisite(s):

ECE 6634:

Multi-Channel Communications

In-depth study of modern multi-channel communications techniques, primarily multi-antenna systems (known as multiple input multiple output or MIMO) and Orthogonal Frequency Division Multiplexing (OFDM). Specifically the course examines multi-antenna techniques such as transmit and receive diversity, beamforming (including eigen-beamforming), and spatial multiplexing. Within the area of OFDM we examine modulation/demodulation, carrier bit loading, mitigating multipath, frequency-domain equalization, peak to average power reduction, and frequency offset mitigation. As time permits we will also investigate a third multi-channel technique known as multi-user scheduling or packet access networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5605, ECE 5654

Corequisite(s):

ECE 6744 (AOE 6744) (ME 6544):

Linear Control Theory

Advanced introduction to the theory of optimal control of time-varying and time-invariant linear systems; Solutions to the linear-quadratic regulator, optimal filtering, and linear-quadratic-gaussian problems; Robustness analysis and techniques to enhance robustness of controllers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5544 OR ME 5554 OR AOE 5744 OR AOE 5754

Corequisite(s):

ECE 6774 (AOE 6774) (ME 6574):

Adaptive Control Systems

Introduction to the theory and methodology used to design adaptive controllers for uncertain systems, addressing issue such as input constraints, disturbance rejection, partial measurements, and robustness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 5774, ECE 5744) OR (ME 5544, ME 5574) OR (AOE 5774, AOE 5744)

Corequisite(s):

ECE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

COMPUTER SCIENCE & APPLICATIONS

Barbara Ryder, Head

Emeriti Faculty: James Arthur; Roger Ehrich; Hillyard Hartson;

Professors: Osman Balci; Christopher Barrett; Douglas Bowman; Kirk Cameron; Ing Ray Chen; Wu-Chun Feng; Edward Fox; Lenwood Heath; Dennis Kafura; Benjamin Knapp; Wenjing Lou; Madhav Marathe; Christopher North; Narendran Ramakrishnan; Calvin Ribbens; Barbara Ryder; Adrian Sandu; Clifford Shaffer; Layne Watson;

Associate Professors: Godmar Back; Ali Butt; Yang Cao; Stephen Edwards; Denis Gracanin; Chang Tien Lu; Donald McCrickard; T Murali; Alexey Onufriev; Manuel Perez-Quinonez; Deborah Tatar; Eli Tilevich; Anil Vullikanti; Danfeng Yao; Liqing Zhang;

Assistant Professors: Yong Cao; Bodicherla Aditya Prakash;

Affiliated Faculty: Nicholas Polys;

Elizabeth and James E. Turner Jr. '56 Faculty Fellowship: Wu-Chun Feng;

Associate Professor of Practice: Steven Harrison;

Research Scientists: Andrea Kavanaugh;

Thomas L. Phillips Professor of Engineering: Narendran Ramakrishnan;

J. Byron Maupin Professor: Barbara Ryder;

Graduate Contact: gradprog@cs.vt.edu

Graduate Site: <http://www.cs.vt.edu/graduate>

Student Handbook: <https://www.cs.vt.edu/graduatehandbook>

The graduate program at the Department of Computer Science at Virginia Tech is poised to become one of the top programs in the country. Recent accolades to the program include ranking as a top-30 program in the US (by number of Ph.D. degrees awarded) and as a "top 10 IT program to watch" by Computerworld.

SPECIAL FACILITIES

Laboratories in the Department of Computer Science in Blacksburg is distributed across three buildings: McBryde Hall, Torgersen Hall, and the KnowledgeWorks II (KWII) building in the Corporate Research Center (CRC). The Department of Computer Science at NCR is housed at the Virginia Tech NCR building in Falls Church.

Bioinformatics Lab

The bioinformatics group on campus hosts and maintains several dedicated resources. The Espresso database server provides over 2TB of storage and is accessible to any of our research workstations & servers via our internal Gig-E network. Baobab is a 20 node Gig-E research cluster with 2 processors & 4GB of memory per node. Mnemosyne is a high memory workstation for intense memory usage calculations and is used by graduate and faculty researchers for large dataset manipulation. Kuprin is a new Dual NVidia Tesla GPU processor machine using nVidia GT200 [Tesla C1060] cards.

Center for High-End Computing Systems (CHECS)

System G: The System G cluster (above) consists of 324 Mac Pros, each with two 4-core 2.8 GHz Intel Xeon processors (for a total of 2592 processor cores) and eight GB of RAM. The system is the first supercomputer running over quad data rate (QDR) InfiniBand (40Gbs) interconnect technology. System G (for "green") also has unique power-aware capabilities, with thousands of power and thermal sensors allowing CHECS researchers to design and develop algorithms and systems software that achieve high-performance with modest power requirements, and to test such systems at unprecedented scale. System G has a sustained (Linpack) performance of 22.8 TFlops.
Imola cluster: This cluster, built by the PEARL (Parallel Emerging Architectures Research Lab), features four 8-way nodes with dual-core AMD Opteron Socket-F processors running at 2.4 GHz. Each node is organized in a NUMA topology with 8 dual-core processor sub-nodes, 2 GB of memory per processor sub-node and a HyperTransport interconnect. The nodes are connected with GigE. The cluster features customized OS modules for power management and memory management to achieve maximum efficiency in scientific HPC workloads.
PlayStation3 cluster: Students and faculty from the SCAPE (Scalable Performance Laboratory), PEARL and SyNeRG (Systems, Networking, and Renaissance Grokking) Lab have built a 24-node cluster out of PS3s.
ICE cluster: The SyNeRG lab

has a 9-node (36-core) ICE cluster, made up of dual-core, dualprocessor AMD Opteron 2218 CPUs and used primarily for research in power-aware computing and high-performance networking.
System X: CHECS works closely with Virginia Tech's Advanced Research Computing facility (VT-ARC). The most powerful system available through VTARC is System X, an 1100 node (2200 processor) cluster, which was designed and built under the leadership of CHECS faculty members. Each System X node is a dual processor (64 bit, 2.3 GHz IBM PPC970) Apple G5 Xserve with 4 GB of memory and a 80GB disk, for an aggregate 4.4 terabytes of main memory and 88 terabytes of temporary storage. In addition, a 53 terabyte network-attached storage facility is available to System X users. The nodes of System X are interconnected over two communication fabrics: an Infiniband switching fabric and a Gigabit Ethernet fabric. The 2304 port Infiniband fabric provides 20 Gbps bandwidth per node with less than 8 microsecond latency, and is the primary communication fabric for parallel communication. The 1200 port switched Gigabit Ethernet fabric is used for system management and job startup. System X has a peak performance of 20.24 TeraFlops with a sustained performance of 12.25 TeraFlops.
VT-ARC shared-memory systems: VT-ARC currently has three SGI Altix systems which support shared-memory parallel applications, with 20, 64 and 128 processors, respectively.
Anantham: A 200-node linux cluster is available to CHECS members for parallel code development and debugging, and to collaborators from the College of Engineering for production computational science and engineering applications. Associated most closely with the Laboratory for Advanced Scientific Computing and Applications (LASCA), the Anantham cluster includes 400 2.0GHz AMD Opteron processors, with 200 GB of memory and 2.0 terabytes of disk space. The nodes of the cluster are interconnected by fast Ethernet and a 2.56 Gb/s Myrinet network.
Ojibwa: LASCA also houses a shared memory Sun Fire X4600 M2 Server with 8 nodes, 32 cores, 64 GB of memory, and 584 GB of disk space.

Center for Human-Computer Interaction (CHCI)

The rapid growth of HCI research at Virginia Tech has resulted in several laboratories housed in the KWII building. Included are: Ten 145 square foot project rooms, some with two-way observation windows; A 280 square foot general HCI laboratory; A 2,330 square foot shared laboratory space incorporating: The Aware Laboratory containing extensive instrumentation for meeting participant tracking and gesture, voice and video analysis; The Gigapixel Display Laboratory (directed by Christopher L. North) containing several large, high-resolution displays; The Virtual and Augmented Reality Laboratory (directed by Denis Gracanin) containing immersive displays and tracking systems; The 3D Interaction Laboratory (directed by Doug Bowman) containing a wide variety of 3D and advanced input devices, as well as virtual environment display technology; and Extensive conference and meeting facilities. The CHCI core laboratories are co-located so that equipment from any

laboratory is readily available for use in another laboratory. The space in KWII brings together facilities that previously could not be spatially co-located due to the rapid expansion of HCI research at Virginia Tech. Below are descriptions of the CHCI core laboratories. **Aware Laboratory:** The Aware Laboratory provides space and infrastructure for research in human multimodal interaction, computer vision, and multimedia data access. The space features a 1,100 sq ft aware meeting room. A suite of 10 genlocked and pair-wise calibrated cameras (recording into digital disks) and a Vicon near-infrared motion capture system featuring 8 high-speed, high-resolution cameras capture the visual behavior of meeting participants. A set of eight close-talking Countryman microphones with wireless transmitter/receivers and a pair of desktop microphones capture synchronized audio into a digital audio recorder. All video, motion- capture, and audio devices are genlocked to a single black-burst generator. A suite of Macintosh G5 computers provide the computation and video handling. **Gigapixel Display Laboratory:** The Gigapixel Display Laboratory provides infrastructure for research using large-scale, high- resolution, and reconfigurable displays. Currently two display technologies are being utilized: tiled LCD panels and stackable rearprojection blocks. The largest tiled LCD display features fifty 17-inch panels with thin bezels, each capable of displaying 1600x1200 pixels, for a total of more than 100 million pixels. The panels are attached to columns, and each column can be moved or rotated, allowing the display to be reconfigured in various form factors (flat, curved, angled, etc.). Twenty-five ?shuttle? PCs drive two displays each, with a head node coordinating rendering. The facility also includes various smaller tiled LCD prototypes, including several that are used routinely for individuals? daily work. The rear-projected display is based on VisBlocks, a stackable modular system from Visbox, Inc. Each block has a rigid frame and screen and an LCD projector, and blocks can be moved and stacked n a variety of configurations. The main advantage to this technology is seamlessness; there are no bezels between adjacent blocks. The facility contains 18 VisBlocks, each capable of displaying 1280x720 pixels; these are driven by nine PCs. **Virtual and Augmented Reality Laboratory:** The VR/AR laboratory provides space for students and faculty working on immersive virtual environments and augmented reality research. A key feature of the lab is the open tracked space allowing unencumbered use of head-mounted displays (HMDs). This 12x12-foot space is tracked with an Intersense IS-900 position tracking system. Other equipment in the lab includes Virtual Research and Sony HMDs, a Fakespace Immersive Workbench? stereoscopic display, a Polhemus Fastrak position tracking system with three receivers, Fakespace pinch glove input devices, and a variety of graphics workstations. **3D Interaction Laboratory:** The 3DI laboratory supports research in 3D user interfaces and interaction techniques, as well as immersive virtual environments. Position tracking is provided in this laboratory by an Intersense IS-900 VET system and a Polhemus Fastrak system. In addition to the tracked

input devices provided by these systems, the laboratory also provides advanced input devices such as Pinch Gloves, 5DT data gloves, a chord keyboard, Measurand ShapeTape, 3D Connexion SpaceBall, and various handheld mice. Display systems include a Virtual Research V8 HMD, and a two-wall rear-projected VisWall system capable of displaying stereoscopic imagery at 2800x1050 pixels. These walls are also reconfigurable and expandable.

General Departmental Resources

The Department maintains a centralized set of compute resources to support departmental email, backup, file serving, web serving and instruction. These resources include six servers that support virtual servers (via Xen hypervisor) for departmental e-mail, web and file serving; a fiber optic SAN to meet the storage and backup needs of the department; a tape library with off-site storage for backups; a 20 node cluster that supports undergraduate and graduate courses; and dedicated HVAC and UPS systems. In addition, various research groups offer special-purpose facilities to their members.

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (79.0)

GRE

General Test: Verbal, Quantitative, Analytical

The Master of Science degree provides a solid foundation in computer science while still offering flexibility to meet the needs and interests of individual students. The M.S degree is completed through either the thesis or the coursework option. The thesis option requires 30 credits of course work of which typically 21-24 credits must derive from courses and 6-9 credits from research work. The coursework option requires 33 credits derived from courses and a project (completed as Independent Study). Students in good standing typically complete either degree option in at most two years. The thesis option is strongly encouraged since it provides students with an in-depth research experience, and requires fewer courses. To encourage Masters graduates to exhibit sufficient breadth of computer science areas, M.S. thesis students must take CS courses spanning four (4) different areas and M.S. coursework students must take CS courses spanning five (5) different areas. At least one advanced graduate course must be included on the plan of study. To enable the completion of both a bachelor's and a master's degree (B.S./M.S.) in five years, Virginia Tech allows students with a 3.5 or above GPA to apply for admission to the Graduate School on the completion of seventy-five hours of undergraduate study. Students in this program take four graduate courses during their senior year in place of the four required CS 4000-level courses. No more than two graduate-level courses should be taken in one semester while an undergraduate, and no more than a total of 12 graduate credits will count toward the undergraduate degree. An average of B (3.0) must be earned over the

four graduate courses on the Undergraduate Program of Study. Award of the B.S. degree occurs on completion of 120 credits, including the 12 credits of graduate work and the other departmental and university core curriculum requirements. The remaining graduate courses for the M.S. degree should be taken after conferral of the B.S. degree and follow the requirements for the M.S. degree as set forth previously. Typically, a BS student transitions to the BS/MS program after completing 75 hours of undergraduate study and, after completing all the requirements of the undergraduate program, transitions to become a regular MS student.

Degree Concentrations:

Bioinformatics Option

An M.S. or Ph.D. degree may include an option in Bioinformatics.

Students receiving the option will have that fact noted on their transcript upon successful graduation. To receive the option, students will take a minimum of seven (7) additional credits beyond those necessary for the degree without the option. These and other requirements as noted next:

- o Students receiving the Bioinformatics option must take PPWS 5314 Biological Paradigms for Bioinformatics (3 credits), BCHM 5024 Computational Biochemistry for Bioinformatics (3 credits), and GBCB 5004 Seminar (1 credit). PPWS 5314, BCHM 5024, and GBCB 5004 may not be used both to complete the option and to satisfy CSA degree course requirements. Students who already have background equivalent to PPWS 5314 and/or BCHM 5024 may be permitted to substitute more advanced courses to satisfy this requirement.
- o Students receiving the Bioinformatics option must take ONE of STAT 5615 (Statistics in Research), STAT 5616 (Statistics in Research), MATH 5515 (Modeling and Simulation of Biological Systems), or MATH 5516 (Modeling and Simulation of Biological Systems). These courses may also be used to fulfill CSA coursework requirements.
- o Students must complete the final exam requirement for their respective CSA degree using a topic suitable for the Bioinformatics option. MS coursework-only students must take GBCB 5874 Problem Solving in Genetics, Bioinformatics, and Computational Biology, and use the final report from this course to satisfy their final exam requirement.

Graduate Certificate in Human-Computer Interaction

A Graduate Certificate in Human-Computer Interaction Program is administered by the Center for Human-Computer Interaction and offered in conjunction with either a master's or doctoral degree. Master's degree students complete 9 hours and doctoral students 15 hours of coursework for the certificate; at least two of the courses taken must be outside the CS degree program requirements and outside CS. Students interested in the Graduate Certificate in Human-Computer Interaction should confer with the director of the Center for Human-Computer Interaction (<http://www.hci.vt.edu>) prior to submitting a program of study to the Graduate School.

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (79.0)

GRE

General Test: Verbal, Quantitative, Analytical

A student pursuing the Ph.D. degree is expected to exhibit a comprehensive knowledge of a broad cross section of the computer science discipline and to contribute significant new knowledge to the discipline through the research contribution contained in the doctoral dissertation. A PhD student must complete a minimum of 90 credits of graduate study, of which at least 33 must derive from courses. The PhD program is intended to be completed in about five years from entering the graduate program with a BS degree in Computer Science or a related field, or about four years if the student already has an MS degree in Computer Science or a related field. To encourage Ph.D. graduates to exhibit sufficient breadth of computer science and its application areas, Ph.D. students must take CS courses spanning five (5) computer science different areas and two cognate (i.e., outside CS) courses. At least two advanced CS graduate courses must be included on the plan of study. To enable the completion of both a bachelor's and a master's degree (B.S./M.S.) in five years, Virginia Tech allows students with a 3.5 or above GPA to apply for admission to the Graduate School on the completion of seventy-five hours of undergraduate study. Students in this program take four graduate courses during their senior year in place of the four required CS 4000-level courses. No more than two graduate-level courses should be taken in one semester while an undergraduate, and no more than a total of 12 graduate credits will count toward the undergraduate degree. An average of B (3.0) must be earned over the four graduate courses on the Undergraduate Program of Study. Award of the B.S. degree occurs on completion of 120 credits, including the 12 credits of graduate work and the other departmental and university core curriculum requirements. The remaining graduate courses for the M.S. degree should be taken after conferral of the B.S. degree and follow the requirements for the M.S. degree as set forth previously. Typically, a BS student transitions to the BS/MS program after completing 75 hours of undergraduate study and, after completing all the requirements of the undergraduate program, transitions to become a regular MS student.

Degree Concentrations:

Bioinformatics Option

An M.S. or Ph.D. degree may include an option in Bioinformatics.

Students receiving the option will have that fact noted on their transcript upon successful graduation. To receive the option, students will take a minimum of seven (7) additional credits beyond those necessary for the degree without the option. These and other requirements as noted next:

- o Students receiving the Bioinformatics option must take PPWS 5314 Biological Paradigms for Bioinformatics (3 credits), BCHM 5024 Computational Biochemistry for Bioinformatics (3 credits), and GBCB 5004 Seminar (1 credit). PPWS 5314, BCHM 5024, and GBCB 5004 may not be used both to complete the option and to satisfy CSA degree course requirements. Students who already have background equivalent to PPWS 5314 and/or BCHM 5024 may be permitted to substitute more advanced courses to satisfy this requirement.
- o Students receiving the

Research), STAT 5616 (Statistics in Research), MATH 5515 (Modeling and Simulation of Biological Systems), or MATH 5516 (Modeling and Simulation of Biological Systems). These courses may also be used to fulfill CSA coursework requirements. o Students must complete the final exam requirement for their respective CSA degree using a topic suitable for the Bioinformatics option. MS coursework-only students must take GBCB 5874 Problem Solving in Genetics, Bioinformatics, and Computational Biology, and use the final report from this course to satisfy their final exam requirement.

Graduate Certificate in Human-Computer Interaction

A Graduate Certificate in Human-Computer Interaction Program is administered by the Center for Human-Computer Interaction and offered in conjunction with either a master's or doctoral degree. Master's degree students complete 9 hours and doctoral students 15 hours of coursework for the certificate; at least two of the courses taken must be outside the CS degree program requirements and outside CS. Students interested in the Graduate Certificate in Human-Computer Interaction should confer with the director of the Center for Human-Computer Interaction (<http://www.hci.vt.edu>) prior to submitting a program of study to the Graduate School.

GRADUATE COURSES (CS)

CS 5014:

Research Methods in Computer Science

Preparation for research in computer science. Technical communication skills. Design and evaluation of experiments. The research process. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CS 5044:

Object-Oriented Programming with Java

Object-oriented programming concepts and the Java programming language. The application of design strategies, notations, and patterns related to object-oriented systems. Techniques and libraries for developing applications related to the World Wide Web. Credit will not be given for both 2704 and 5044. Not for Computer Science major or minor credit; not for graduate credit for CSA or INFS programs. Pre:

Proficiency in a high-level programming language (e.g., FORTRAN, C, C++, or Java) equivalent to 1044 and prior course work, practical training, or work experience related to developing computer software and systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CS 5104:

Computability and Formal Languages

Formal theory of computability, the halting problem, models of computation, and Church's thesis, and formal languages. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5034

Corequisite(s):

CS 5114:

Theory of Algorithms

Methods for constructing and analyzing algorithms. Measures of computational complexity, determination of efficient algorithms for a variety of problems such as searching, sorting and pattern matching. Geometric algorithms, mathematical algorithms, and theory of NP-completeness. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 2604

Corequisite(s):

CS 5124:

Algorithms in Bioinformatics

Algorithms to solve problems found in biology, especially molecular biology. A variety of current problems in computational molecular biology will be introduced, investigated, analyzed for computational complexity, and solved with efficient algorithms, when feasible. A number of such problems will be shown to be intractable or other evidence of their difficulty will be presented. Prerequisites or graduate standing in CSA required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CS 4104 (UG) OR CS 5046 (UG), PPWS 5314 (UG))

Corequisite(s):

CS 5204:

Operating Systems

Issues in the design and functioning of operating systems. Emphasis on synchronization of concurrent activity in both centralized and distributed systems. Deadlock, scheduling, performance analysis, operating system design, and memory systems including distributed file systems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 3204 (UG) OR CS 3204

Corequisite(s):

CS 5214:

Modeling and Evaluation of Computer Systems

An overview of modeling, simulation, and performance evaluation of computer systems, i.e., operating systems, database management systems, office automation systems, etc. Fundamentals of modeling, the life cycle of a simulation study, workload characterization, random number and variate generation, procurement, measurement principles, software and hardware monitors, capacity planning, system and program tuning, and analytic modeling. Duplication of subject matter of 4214 and 4224. Maximum of 6 hours credit may be obtained from 4214, 4224, 5214. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CS 5024 (UG), STAT 4705 (UG)) OR (STAT 4714 (UG), STAT 4105 (UG)) OR (CS 5024, STAT 4705) OR (STAT 4714, STAT 4105)

Corequisite(s):

CS 5224:

Systems Simulation

An in-depth treatment of systems simulation and simulation programming languages (SPLs). Input data modeling, simulation model formulation and representation, conceptual frameworks for modeling, a comparative study of some SPLs, principles of SPL design, statistical analysis of simulation output data, credibility assessment stages, model development environments. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CS 5204 (UG), STAT 4105 (UG)) OR (STAT 4714 (UG), STAT 4705 (UG)) OR (CS 5204, STAT 4105 OR STAT 4714, STAT 4705)

Corequisite(s):

CS 5234:

Advanced Parallel Computation

Survey of leading high-end computing systems and their programming environments. Advanced models of parallel computation. Mapping of parallel algorithms to architectures. Performance programming and tools for performance optimization on parallel systems. Execution environments and system software for large-scale parallel computing. Case studies of parallel applications. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 4234 (UG) OR CS 4234

Corequisite(s):

CS 5244:

Internet Software

Languages and technologies needed to develop software for the Internet and world-wide web (WWW). Commonly used protocols and standards. Advanced technologies for distributed computation, component-based systems, interoperability with legacy systems, and database access. Principles and technologies for agent-based systems and electronic commerce. Credit will not be given for both 4244 and 5244.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CS 5044 (UG) OR CS 5044

Corequisite(s):

CS 5304:

Translator Design and Construction

Fundamental theory of parsing and translation and practical applications of this theory. Lexical analysis, parsing techniques based on top-down (LL, Recursive Descent) and bottom-up (LR, Precedence), code generation, code optimization techniques, and runtime systems. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CS 4114 (UG) OR CS 5034 (UG)) OR (CS 4114 OR CS 5034)

Corequisite(s):

CS 5314:

Programming Languages

In depth investigation of the principles of programming systems, not necessarily restricted to programming languages, both from the point of view of the user implementor. Algorithms of implementation, syntax and semantic specification systems, block structures and scope, data abstraction and aggregates, exception handling, concurrency, and applicative/functional/data-flow languages. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 3304 (UG) OR CS 3304

Corequisite(s):

CS 5424 (BIOL 5424) (GBCB 5424):

Computational Cell Biology

Use of mathematical models (nonlinear ordinary differential equations and stochastic processes) and simulation algorithms to explore the complex feedback circuits that control the behavior of living cells. Concepts and techniques from dynamical systems theory, bifurcation analysis, numerical methods, SBML (systems biology markup language) and Matlab programming. Applications in gene regulatory networks, cell cycle control, circadian rhythms, cell signaling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 5515

Corequisite(s):

CS 5465 (MATH 5465):

Numerical Analysis

A survey of the construction, analysis, and implementation of numerical algorithms in linear algebra, nonlinear equations and optimization, approximation by polynomials, quadrature, and ordinary differential equations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5466 (MATH 5466):

Numerical Analysis

A survey of the construction, analysis, and implementation of numerical algorithms in linear algebra, nonlinear equations and optimization, approximation by polynomials, quadrature, and ordinary differential equations. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5474 (MATH 5474):

Finite Difference Methods for Partial Differential Equations

Finite difference methods for initial and boundary value problems for partial differential equations. Consistency, stability, convergence, dispersion, and dissipation. Methods for linear and nonlinear elliptic and parabolic equations, first- and second-order hyperbolic equations, and nonlinear conservation laws. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 3414 (UG) OR CS 3414

Corequisite(s):

CS 5484 (MATH 5484):

Finite Element Methods for Partial Differential Equations

Weak formulations of boundary-value problems for elliptic partial differential equations. Finite element spaces. Approximation theory for finite element spaces. Error estimates. Effects of numerical integration and curved boundaries. Nonconforming methods. Concrete examples of the application of the finite element method. Efficient implementation strategies. Time dependent problems. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 3414 (UG) OR CS 3414

Corequisite(s):

CS 5485 (MATH 5485):

Numerical Analysis and Software

Presentation and analysis of numerical methods for solving common mathematical and physical problems. Methods of solving large sparse linear systems of equations, algebraic eigenvalue problems, and linear least squares problems. Numerical algorithms for solving constrained

and unconstrained optimization problems. Numerical solutions of nonlinear algebraic systems. Convergence, error analysis. Hardware and software influences. Efficiency, accuracy, and reliability of software.

Robust computer codes. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (MATH 4445 (UG), MATH 4446 (UG)) OR (MATH 4445, MATH 4446)

Corequisite(s):

CS 5486 (MATH 5486):

Numerical Analysis and Software

Presentation and analysis of numerical methods for solving common mathematical and physical problems. Methods of solving large sparse linear systems of equations, algebraic eigenvalue problems, and linear least squares problems. Numerical algorithms for solving constrained and unconstrained optimization problems. Numerical solutions of nonlinear algebraic systems. Convergence, error analysis. Hardware and software influences. Efficiency, accuracy, and reliability of software.

Robust computer codes. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (MATH 4445 (UG), MATH 4446 (UG)) OR (MATH 4445, MATH 4446)

Corequisite(s):

CS 5504 (ECE 5504):

Computer Architecture

Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, programming and interconnection network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CS 4504 (UG) OR CS 4504

Corequisite(s):

CS 5510 (ECE 5510):

Multiprocessor Programming

Principle and practice of multiprocessor programming. Illustration of

multiprocessor programming principles through the classical mutual exclusion problem, correctness properties of concurrency (e.g., linearizability), shared memory properties (e.g. register constructions), and synchronization primitives for implementing concurrent data structures (e.g., consensus protocols). Illustration of multiprocessor programming practice through programming patterns such as spin locks, monitor locks, the work-stealing paradigm and barriers. Discussion of concurrent data structures (e.g., concurrent linked lists, queues, stacks, hash maps, skiplists) through synchronization patterns ranging from coarse-grained locking to fine-grained locking to lock-free structures atomic synchronization primitives, elimination, and transactional memory.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4534 OR ECE 4550

Corequisite(s):

CS 5515:

Computer and Network Architectures

5515: Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, program and network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors. 5516: Local area networks, wide area networks, and internets. Protocols and the ISO Open Systems Interconnect reference model. Design, analysis, and performance evaluation. Emphasis on data link, network, and transport protocols. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4504 (UG) OR CS 4504 (UG)) OR (ECE 4504 OR CS 4504)

Corequisite(s):

CS 5516:

Computer and Network Architectures

5515: Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, program and network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors. 5516: Local area networks, wide area networks, and internets. Protocols and the ISO Open Systems Interconnect reference model. Design, analysis, and performance evaluation. Emphasis on data link, network, and transport protocols. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (ECE 4504 (UG) OR CS 4504 (UG)) OR (ECE 4504 OR CS 4504)

Corequisite(s):

CS 5525 (STAT 5525):

Data Analytics

Basic techniques in data analytics including the preparation and manipulation of data for analysis and the creation of data files from multiple and dissimilar sources. The data mining and knowledge discovery process. Overview of data mining algorithms in classification, clustering, association analysis, probabilistic modeling, and matrix decompositions. Detailed study of classification methods including tree-based methods, Bayesian methods, logistic regression, ensemble, bagging and boosting methods, neural network methods, use of support vectors and Bayesian networks. Detailed study of clustering methods including k-means, hierarchical and self-organizing map methods. Prerequisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5526 (STAT 5526):

Data Analytics

Techniques in unsupervised and visualized learning in high dimension spaces. Theoretical, probabilistic, and applied aspects of data analytics. Methods include generalized linear models in high dimensional spaces, regularization, lasso and related methods, principal component regression (pca), tree methods, and random forests. Clustering methods including k-means, hierarchical clustering, biclustering, and model-based clustering will be thoroughly examined. Distance-based learning methods include multi dimensional scaling, the self organizing map, graphical/network models, and isomap. Supervised learning will consist of discriminant analyses, supervised pca, support vector machines, and kernel methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5525

Corequisite(s):

CS 5560 (ECE 5560):

Network and Computer Security

Introduces both fundamental security principles as well as real-world applications of network and computer security. Covers a wide range of topics including authorization and access control, basic cryptography, authentication systems, e-commerce security, sensor network security, and legal and ethical issues. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4564 (UG) OR ECE 4564 OR CS 4254 (UG) OR CS 4254 OR ECE 5565 OR CS 5565

Corequisite(s):

CS 5565 (ECE 5565):

Network Architecture and Protocols

5565: Principles and concepts of networking and protocols, with emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.
5566: Performance evaluation, design, and management of networks. Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols. Network management architectures and protocols. Graduate standing in EE, ECE, CS, or IT required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

CS 5566 (ECE 5566):

Network Architecture and Protocols

5565: Principles and concepts of networking and protocols, with emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.
5566: Performance evaluation, design, and management of networks. Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols. Network management architectures and protocols. Graduate standing in EE, ECE, or IT is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CS 5565 (UG) OR CS 5565

Corequisite(s):

CS 5604:

Information Storage and Retrieval

Analyzing, indexing, representing, storing, searching, retrieving, processing and presenting information and documents using fully automatic systems. The information may be in the form of text, hypertext, multimedia, or hypermedia. The systems are based on various models, e.g., Boolean logic, fuzzy logic, probability theory, etc., and they are implemented using inverted files, relational thesauri, special hardware, and other approaches. Evaluation of the systems' efficiency and effectiveness. Graduate standing required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5614:

Database Management Systems

Emphasizes concepts, data models, mechanisms, and language aspects concerned with the definition, organization, and manipulation of data at a logical level. Concentrates on relational model, along with introduction to design of relational systems using Entity-relationship modeling.

Functional dependencies and normalization of relations. Query languages, relational algebra, Datalog, and SQL. Query processing, logic and databases, physical database tuning. Concurrency control, OLTP, active and rule-based elements. Data Warehousing, OLAP.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 2604 (UG) OR CS 2604

Corequisite(s):

CS 5624:

Introduction to Data Mining

Basic principle of data mining, including data analysis under uncertainty, modeling of data mining problems, data mining algorithms, scalability, and data integration and management. Applications of data mining in areas such as bioinformatics, electronic commerce, and geoinformatics.

Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5634:

Data Management in Bioinformatics

Data models, query languages, and data management systems for bioinformatics applications. Logical data organization, functional dependencies, design of schemas, querying, manipulation, information integration, and data mining. Specialized data structures, interchange formats, and designs for applications such as sequencing and microarray analysis. Partially duplicates 5614. Prerequisite or graduate standing in CSA required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5046 (UG) OR CS 5046

Corequisite(s):

CS 5704:

Software Engineering

Study of the principles and tools applicable to the methodical construction and controlled evolution of complex software systems. All phases of the life cycle are presented; particular attention focuses on the design, testing, and maintenance phases. Introduction to software project management. Attention to measurement models of the software process and product which allow quantitative assessment of cost, reliability, and complexity of software systems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CS 5034

Corequisite(s):

CS 5714 (ISE 5714):

Usability Engineering

Design and evaluation of effective user interfaces, beginning with principles for designing the product. Development process for user interaction separate from interactive software development.

Development process includes iterative life cycle management, systems analysis, design, usability specifications, design representation

techniques, prototyping, formative user-based evaluation. Integrative and cross-disciplinary approach with main emphasis on usability methods and the user interaction development process. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5724:

Models and Theories of Human-computer Interaction

Survey of models and theories of users and their use of computer equipment; conditions of application for various approaches. Task analysis, task modeling, representations and notations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5734:

Computer-supported Cooperative Work

Review and critique of state-of-the-art computing systems supporting cooperative work. Introduction to toolkits, software architectures and implementation issues relevant to development of systems for cooperative work. Analysis of group interactions and concerns in collaborative activities such as writing, design, meetings, communication, and decision-making. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5744:

Software Design and Quality

This course focuses on critical aspects of the software lifecycle that have significant influence on the overall quality of the software system including techniques and approaches to software design, quantitative measurement and assessment of the system during implementation, testing, and maintenance, and the role of verification and validation in assuring software quality.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CS 5704 (UG) OR CS 5704

Corequisite(s):

CS 5754:

Virtual Environments

Introduction to the theory and practice of three-dimensional virtual environments (VEs). 3D input and output devices, applications of VEs, 3D user interfaces and human-computer interaction, 3D graphics techniques for VEs, 3D modeling and level of detail, evaluation of VEs, VE software systems and standards, collaborative and distributed VEs. Includes hands-on experience with VE hardware and software.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5764:

Information Visualization

Examine computer-based strategies for interactive visual presentation of information that enable people to explore, discover, and learn from vast quantities of data. Learn to analyze, design, develop, and evaluate new visualizations and tools. Discuss design principles, interaction strategies, information types, and experimental results. Research-oriented course surveys current literature, and group projects contribute to the state of the art.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 2604 (UG) OR CS 2604

Corequisite(s):

CS 5774:

User Interface Software

Survey of software architectures to build user interfaces, particularly focused on graphical user interfaces. Includes the design and implementation of user interfaces, the use of object-oriented application frameworks, software architecture for command undo, document management, layout managers, customized components, and separation of concerns in user interface software architectures. Discussion of research and advanced topics in User Interface Software.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 2704 (UG) OR CS 2704

Corequisite(s):

CS 5804:

Introduction to Artificial Intelligence

A graduate level overview of the areas of search, knowledge representation, logic and deduction, learning, planning, and artificial intelligence applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CS 2604 (UG) OR CS 2604

Corequisite(s):

CS 5814:

Digital Picture Processing

Representation and processing of greytone images. Construction and simulation of grey scales, digitization, thresholding, local neighborhood operations, template matching and filtering, enhancement and restoration, segmentation, connected components, matching, morphology. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 1704, MATH 1114

Corequisite(s):

CS 5854:

Computational Systems Biology

Phenomenological and data-driven models of molecular interaction networks. Applications of graph theory, discrete algorithms, data mining, and machine learning to the modeling and analysis of molecular interaction networks. Biological applications. Interaction between biological and computational disciplines in systems biology. Must have GBCB pre-requisite and CS pre-requisites or graduate standing in CSA or equivalent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 4104 (UG) OR CS 4104 OR CS 5046, GBCB 5314

Corequisite(s):

CS 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CS 5944:

Graduate Seminar

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

CS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CS 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CS 6104:

Advanced Topics in Theory of Computation

This course treats a specific, advanced topic of current research interest in the area of theory of computation. Papers from the current literature or research monographs are likely to be used instead of a textbook.

Student participation in a seminar style format may be expected. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5104 (UG) OR CS 5114 (UG) OR CS 5104 OR CS 5114

Corequisite(s):

CS 6204:

Advanced Topics in Systems

This course treats a specific advanced topic of current research interest in the area of systems. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5204 (UG) OR CS 5214 (UG) OR CS 5204 OR CS 5214

Corequisite(s):

CS 6304:

Advanced Topics in Languages and Translation

This course treats a specific advanced topic of current research interest in the area of languages and translation. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5304 (UG) OR CS 5314 (UG) OR CS 5304 OR CS 5314

Corequisite(s):

CS 6404:

Advanced Topics in Mathematical Software

This course treats a specific advanced topic of current research interest in the area of mathematical software. Papers from the current literature or research monographs are likely to be used instead of a textbook.

Student participation in a seminar style format may be expected. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5485 (UG) OR CS 5485

Corequisite(s):

CS 6444 (ME 6444) (AOE 6444):

Verification and Validation in Scientific Computing

Applicable to scientific and engineering models described by partial differential or integral equations. Software engineering, code verification, and the method of manufactured solutions for generating exact solutions. Estimation of numerical approximation errors in scientific computing. Design and execution of experiments for model validation and model accuracy assessment. Propagation of aleatory and epistemic uncertainty through models. Estimation of total prediction uncertainty in scientific computing simulations. Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CS 6504:

Advanced Topics in Computer Architecture

This course treats a specific advanced topic of current research interest in the area of architecture. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5515 (UG) OR CS 5516 (UG) OR CS 5515 OR CS 5516

339 Corequisite(s):

Corequisite(s):

CS 6564 (ECE 6564):

Multimedia Networking

This course examines and explores recent advances in multimedia networking technologies. Major topics include multimedia compression and standards, quality of service (QoS) support mechanisms and protocols, performance analysis, network calculus, IP multicasting, Internet multimedia applications, and multimedia transport over wireless networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5565 (UG) OR CS 5565

Corequisite(s):

CS 6570:

Advanced Foundations of Networking

This course covers theoretical foundations that are necessary for advanced study of networking. It focuses on algorithm design and optimization techniques that are most commonly used to solve complex networking problems. Major topics include complexity analysis with applications to networking problems, design and proof of approximation algorithms, design of meta-heuristic algorithms, formulation techniques for network optimization, linear and non-linear optimization techniques with applications to networking, design of distributed algorithms with proof of convergence for networks systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5565 (UG) OR ECE 5565 (UG) OR CS 5565 OR ECE 5565

Corequisite(s):

CS 6604:

Advanced Topics in Data and Information

This course treats a specific advanced topic of current research interest in the area of data and information. Papers from the current literature or research monographs are likely to be used instead of a textbook.

Student participation in a seminar style format may be expected. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5604 (UG) OR CS 5614 (UG) OR CS 5604 OR CS 5614

CS 6704:

Advanced Topics in Software Engineering

This course treats a specific advanced topic of current research interest in the area of software engineering. Papers from the current literature or research monographs are likely to be used instead of a textbook.

Student participation in a seminar style format may be expected. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5704 (UG) OR CS 5714 (UG) OR CS 5704 OR CS 5714

Corequisite(s):

CS 6724:

Advanced Topics in Human-computer Interaction

Addresses a specific advanced topic of current research interest in the area of human-computer interaction (HCI). Research monographs and papers from the current literature will be used as a source of material too new yet to be in a textbook. Student participation in a seminar-style format. Each offering of this course will address a different subtopic area of HCI. May be repeated for credit. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5714 (UG) OR CS 5724 (UG) OR CS 5734 (UG) OR CS 5714 OR CS 5724 OR CS 5734

Corequisite(s):

CS 6804:

Advanced Topics in Intelligent Systems

This course treats a specific advanced topic of current research interest in the area of intelligent systems. Papers from the current literature or research monographs are likely to be used instead of a textbook.

Student participation in a seminar style format may be expected. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CS 5804 (UG) OR CS 5814 (UG) OR CS 5804 OR CS 5814

Corequisite(s):

Adv Topics Comp Biol & Bioinf

Addresses a specific advanced topic of current research interest in the area of computational biology and bioinformatics (CBB). Research monographs and papers from the current literature used as a source of material too new to be discussed in a textbook. Student participation in a seminar-style format. Each offering of this course will address a different subtopic area of CBB. May be repeated with different content for a maximum of 12 credit hours. Pre: Graduate standing; other pre-requisites may apply.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CS 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ELECTRICAL ENGINEERING

Luke Lester, Head

Emeriti Faculty: James Armstrong; Ioannis Besieris; Charles Bostian; Gary Brown; Richard Conners; Walling Cyre; William Davis; David De Wolf; Festus Gray; Richard Moose; Charles Nunnally; Arun Phadke; Timothy Pratt; Krishnan Ramu; Frederick Stephenson; Warren Stutzman; James Thorp; Hugh VanLandingham;

Professors: Peter Athanas; Aloysius Beex; Dushan Boroyevich; Robert Broadwater; Richard Buehrer; C Clauer; Gregory Earle; Dong Ha; Yiwei Hou; Michael Hsiao; Mark Jones; Jih Lai; Fred Lee; Luke Lester; Thomas Martin; Scott Midkiff; Lamine Mili; Khai Ngo; Mariusz Orlowski; Paul Plassmann; Ting Chung Poon; Saifur Rahman; Sanjay Raman; Binoy Ravindran; Jeffrey Reed; Sedki Riad; Ahmad Safaai-Jazi; Wayne Scales; Sandeep Shukla; Luiz Silva; Daniel Stilwell; William Tranter; Joseph Tront; Yue Wang; Anbo Wang;

Associate Professors: Amos Abbott; Masoud Agah; Scott Bailey; Joseph Baker; William Baumann; Rolando Burgos; Virgilio Centeno; Thomas Clancy; Jaime De La Reelopez; Steven Ellingson; Louis Guido; Mantu Hudait; Douglas Lindner; Allen MacKenzie; Leyla Nazhandali; Willem Odenaal; Jung-Min Park; Cameron Patterson; JoAnn Paul; John Ruohoniemi; Patrick Schaumont; Kwa Sur Tam; Chris

Wyatt; Jianhua Xuan; Yaling Yang;

Assistant Professors: Dhruv Batra; Harpreet Singh Dhillon; Kwang-Jin Koh; Qiang Li; Majid Manteghi; Rosalyn Moran; Devi Parikh; Walid Saad; Chao Wang; Yong Xu; Guoqiang Yu; Haibo Zeng; Yizheng Zhu;

Grant A. Dove Professor: Yue Wang;

Bradley Distinguished Professor of Electromagnetics: Gary Brown;

Hugh P and Ethel C Kelly Professor: James Thorp;

Alumni Distinguished Professor: Charles Bostian;

Bradley Professor of Communications: William Tranter;

Willis Worcester Professor: Jeffrey Reed;

University Distinguished Professor: Fred Lee; Arun Phadke;

Clayton Ayre Professor: Anbo Wang;

American Electric Power Professor: Dushan Boroyevich;

Joseph R. Loring Professor: Saifur Rahman;

Thomas L. Phillips Professor: Warren Stutzman;

Virginia Microelectronics Consortium Chair: Mariusz Orlowski;

Graduate Admissions: vt.ece.gradadm@vt.edu

Graduate Counseling: vt.ece.gradadv@vt.edu

NCR Graduate Coordinator: cdrobi@vt.edu

Student Handbook: <http://www.ece.vt.edu/gradman/manual.php>

The Harry Lynde Bradley Department of Electrical and Computer Engineering offers graduate degree programs leading to the Master of Engineering (M.Eng.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) in electrical engineering and computer engineering. All degree programs are offered through the Blacksburg campus as well as extended campus consortia (National Capital Region, Northern Virginia Center, Falls Church, Virginia; Central; Hampton Roads; Western, and VT-MENA through Alexandria and Cairo, Egypt). For the master's degree, each plan of study, developed by the student in consultation with his or her faculty advisor, must contain a limited number of core courses. The M.S. degree program requires a thesis. The M.Eng. is a non-thesis degree program and is especially suitable for part-time graduate students employed as engineers by industry and government agencies. The Ph.D. degree program is research-oriented. Applicants applying for these degrees program must have an earned Master's degree in CPE, EE or related field. A direct-Ph.D. option is available for students without an earned Master's degree. These students will earn a Master of Science, Thesis, or Master of Science, Non-Thesis, degree in addition to the Ph.D. The Bradley Department of Electrical and Computer Engineering's current enrollment is approximately 525 students. Out of the enrolled students, approximately 95% of our full-time Ph.D. students are funded and approximately 75% of our full-time Master's student are funded. Funding is available in three ways: Graduate Teaching Assistantships - Awarded by the department Graduate Research Assistantships - Awarded by individual faculty Fellowships - Awarded by the department to the very top applicants to the program. Of the fellowships awarded by the department, the Bradley Fellowship is the highest honor bestowed on ECE Ph.D. students and is restricted to U.S. citizens only.

SPECIAL FACILITIES

Well-equipped research facilities, labs, and centers are available within the different research areas. For more information, click here.

DEGREES OFFERED

MEng Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Blacksburg, Richmond)

TOEFL

Paper: (590.0)

Computer: (243.0)

iBT: (96.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Writing (4.5)

IELTS

General: Band (7.5)

32 credit hours 27 credit hours of course work 3 credit hours of project and report 2 credit hours of seminar The ECE Graduate Student Policy Manual gives detailed information pertaining to degree requirements.

Degree Concentrations:

Research Areas

The outstanding ECE faculty is world-renowned for teaching and research. Students can select an area of research from the following Computer Engineering areas available through the Bradley Department of Electrical and Computer Engineering: Communications Electromagnetics Electronics and Circuits Signals, Systems, and Controls Power

MS Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Blacksburg, Richmond)

TOEFL

Paper: (590.0)

Computer: (243.0)

iBT: (96.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Writing (4.5)

IELTS

General: Band (7.5)

32 credit hours 21 credit hours of course work 9 credit hours of research and thesis 2 credit hours of seminar The ECE Graduate Student Policy Manual gives detailed information pertaining to degree requirements.

Degree Concentrations:

Research Areas

The outstanding ECE faculty is world-renowned for teaching and research. Students can select an area of research from the following Computer Engineering areas available through the Bradley Department of Electrical and Computer Engineering: Communications

Electromagnetics Electronics and Circuits Signals, Systems, and Controls Power

PhD Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Blacksburg, Richmond)

TOEFL

Paper: (590.0)

Computer: (243.0)

iBT: (96.0)

GRE

General Test: Verbal (153.0), Quantitative (157.0), Writing (4.5)

IELTS

General: Band (7.5)

Regular PhD Requirements (for students with an earned Masters):92 credit hours 30 credit hours of course work 60 credit hours of research and thesis 2 credit hours of seminar Direct-PhD Requirements (for students with only an earned Bachelors):MS, Thesis and PhD - 92 credit hours 21 credit hours of coursework for MS (all transfer to PhD) 9 additional credit hours of coursework for PhD 9 hours of research and thesis for MS 60 credit hours of research and dissertation for PhD 2 credit of seminar that will count for both MS and PhD Ms, Non-Thesis and PhD - 92 credit hours 30 credit hours of coursework for MS (all transfer to PhD) 60 credit hours of research and dissertation for PhD 2 credit of seminar that will count for both MS and PhD The ECE Graduate Student Policy Manual gives detailed information pertaining to degree requirements.

Degree Concentrations:

Research Areas

The outstanding ECE faculty is world-renowned for teaching and research. Students can select an area of research from the following Computer Engineering areas available through the Bradley Department of Electrical and Computer Engineering: Communications Electromagnetics Electronics and Circuits Signals, Systems, and Controls Power

GRADUATE COURSES (ECE)

ECE 5015:

Network Synthesis and Design

Positive real and bounded real concepts. Synthesis of two-element-kind lumped networks. Scattering description. Synthesis of RLC impedances. Approximation methods for lumped filters. Synthesis of microwave filters. Synthesis of switched-capacitor networks. Design techniques for active RC filters modeled on classical structures. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

342 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4205

Corequisite(s):

ECE 5016:

Network Synthesis and Design

Positive real and bounded real concepts. Synthesis of two-element-kind lumped networks. Scattering description. Synthesis of RLC impedances. Approximation methods for lumped filters. Synthesis of microwave filters. Synthesis of switched-capacitor networks. Design techniques for active RC filters modeled on classical structures. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4205

Corequisite(s):

ECE 5104:

RF & Microwave Engineering and Applications

A review of basic electromagnetics. Transmission lines, waveguides, microstrip lines, striplines. Microwave networks and impedance matching, Smith chart, S-Matrix, ABCD matrix, transformers. Microwave filters. Active RF components. Microwave amplifier design. Microwave systems. Microwave Integrated Circuits (MIC). RF Microelectromechanical System (MEMS) components. RF components for wireless systems. RF components for Ultra Wideband (UWB) systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4104 (UG) OR ECE 4104

Corequisite(s):

ECE 5104G:

Advanced Microwave and RF Engineering

Passive and active RF 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. Active RF components. Microwave amplifier design. Microwave Integrated Circuits (MIC). RF Microelectromechanical System (MEMS) components. Microwave systems. RF components for wireless systems. RF components for Ultra Wide band (UWB) systems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5105:

Electromagnetic Waves

Maxwell's electromagnetic field theory and its applications to engineering problems. 5105: Fundamental concepts associated with elementary plane wave theory and boundary value problems with applications to half-space reflection problems; fundamental theorems. 5106: Analytical techniques (Green's theory, modal analysis, integral equations, etc.) applied to setting up, approximating, and solving radiation, unguided, and guided wave propagation, and scattering by medium discontinuities in open and closed geometries. Graduate standing required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 3106 (UG) OR ECE 3106

Corequisite(s):

ECE 5106:

Electromagnetic Waves

Maxwell's electromagnetic field theory and its applications to engineering problems. 5105: Fundamental concepts associated with elementary plane wave theory and boundary value problems with applications to half-space reflection problems; fundamental theorems. 5106: Analytical techniques (Green's theory, modal analysis, integral equations, etc.) applied to setting up, approximating, and solving radiation, unguided, and guided wave propagation, and scattering by medium discontinuities in open and closed geometries. Graduate standing required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 3106 (UG) OR ECE 3106 (UG)

Corequisite(s):

ECE 5134G:

Advanced Fiber Optics and Applications

Theory of optical fiber waveguide propagation and design applications in communication and sensing systems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5144:

Introduction to Electro-Optics

Physical optics, wave propagation in inhomogeneous media, acousto-optic and electro-optic effects and their applications in intensity modulation and phase modulation of laser beams. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 3106 (UG), ECE 3614 (UG)) OR (ECE 3106, ECE 3614)

Corequisite(s):

ECE 5160:

Introduction to Space Plasmas

Underlying physical processes in the space environment medium in terms of plasma physics and electrodynamics. Single particle motion, fluid and kinetic theory of plasmas, plasma waves and instabilities, diffusion and resistivity, and a brief introduction to nonlinear effects. Prerequisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5164:

Introduction to Space Science I: The Solar Wind and Magnetosphere

Describes the space environment from the sun to the earth's upper atmosphere. Fundamental concepts in space plasma physics will be presented, as needed, throughout the course. Numerous examples of observations and data will be utilized to illustrate the environment and its dynamic variability. An emphasis will be placed on the practical impacts of this environment and its dynamic variability. An emphasis will be placed on the practical impacts of this environment (space weather) on modern technologies such as solid state devices, satellite technology, communication and global navigation systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 3106 (UG) OR ECE 3106

Corequisite(s): ECE 5105

ECE 5200 (MSE 5200):

Semiconductor Alloys and Heterstructures

Advanced treatment of semiconductor materials with an emphasis on binary compounds, ternary and quaternary alloys, and strained-layer structures. Topics include crystal structure; lattice vibrations and phonons; energy band structure; equilibrium and non-equilibrium carrier distributions; electron and hole transport via diffusion and drift; and carrier generation and recombination mechanisms. Graduate standing required in the College of Engineering or College of Science.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 3204 (UG) OR ECE 4214 (UG) OR PHYS 3455 (UG) OR ECE 4214 OR MSE 3204 OR PHYS 3455

Corequisite(s):

ECE 5204:

Power Semiconductor Devices

Characteristics, fabrication, and application of power semiconductor devices, which may include p-i-n and Schottky diodes, insulated gate bipolar transistors, field effect transistors, and thyristors. Effect of semiconductor material, device structure, and current injection levels on device performance. Device drive requirements and power circuit interaction. Implementation of power devices using wide band gap semiconductors such as silicon carbide and gallium nitride.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5200

Corequisite(s):

ECE 5205:

Basic Semiconductor Devices

Description of the performance characteristics and limitations of basic semiconductor electronic devices in terms of the properties of semiconductor materials and device structure. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

344 Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5206:

Basic Semiconductor Devices

Description of the performance characteristics and limitations of basic semiconductor electronic devices in terms of the properties of semiconductor materials and device structure. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5210:

MicroElectroMechanical Systems: From Fabrication to Application

MicroElectroMechanical Systems (MEMS) are "very-small systems" or "systems made of very small components". The course focuses on the design, fabrication, and application of microsystems providing a unique opportunity for interdisciplinary interactions. The course consists of lectures, readings from the current literature, discussion by students, and team-work projects. The major topics covers are: materials in MEMS; microfabrication techniques; sensing and actuating mechanisms; wafer-level packaging; and case-study of some MEMS-based devices and lab-on-a-chip systems. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4234 (UG) OR ECE 4234 OR BCHM 4124 (UG) OR BCHM 4124 OR CHE 4114 (UG) OR CHE 4114 OR CHEM 4124 (UG) OR CHEM 4124 OR ESM 4014 (UG) OR ESM 4014 OR ESM 4024 (UG) OR ESM 4024 OR ME 4304 (UG) OR ME 4304 OR ME 4404 (UG) OR ME 4404 OR MSE 4254 (UG) OR MSE 4254 OR MSE 4354 (UG) OR MSE 4354

Corequisite(s):

ECE 5214:

Phase-locked Loops: Theory and Practice

Fundamental theory and design concepts of frequency synchronization techniques. Emphasis is on phase-locked loops and applications in communications for frequency synthesis, tracking, and demodulation. Laboratory investigates fundamental principles of operation with a final project to develop specific aspects of a loop in detail. Alternate year course.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405

Corequisite(s):

ECE 5220:

Radio Frequency Integrated Circuit Technology and Design

Integrated circuit (IC) implementation of RF circuits for wireless communications applications. Transceiver architectures for current wireless communications standards; active/passive device technologies for RFIC implementations; low noise amplifiers; mixers; frequency sources; power amplifiers; single-chip radios; and RFIC packaging and testing. Case studies of modern RFIC chip sets for current wireless communications standards are examined. The course involves circuit design at the IC level; modern RF/microwave CAD software will be used in conjunction with the course. Design of a wireless transceiver functional block component RFIC chip. Alternate years. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 3204 (UG), ECE 3614 (UG)), (ECE 4605 (UG) OR ECE 4104 (UG)) OR (ECE 3204, ECE 3614), (ECE 4605 OR ECE 4104)

Corequisite(s):

ECE 5224:

Non-Linear Communication Circuits

Advanced methods of analysis and design of communication circuits with emphasis on nonlinear effects and filtering. Nonlinear device models and their use in the design of oscillators and mixers at HF through UHF frequencies. The design of power amplifiers. I. Alternate years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4605 (UG) OR ECE 4605

Corequisite(s):

ECE 5234:

Emi and Noise Reduction Techniques and Filter Design

Theory and practice of E.M. noise coupling; Techniques for noise reduction: shielding, grounding and filtering. Measurement of EMI to comply with government regulation. EMI problems and solutions to switching power supply applications. Design of EMI filter. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4205 (UG) OR ECE 4224 OR ECE 4205

Corequisite(s):

ECE 5235G:

ADV Electronic Packaging

Design issues such as electrical, electromagnetic, thermal, mechanical, and thermomechanical, are covered at the lower levels of packaging hierarchy. Materials and process selection guidelines are discussed for the manufacturing and reliability of chip carriers, multichip and hybrid modules. Theoretical bases for design methodology and package reliability. Solid modeling for electrical and thermal designs from chip to board. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5236G:

ADV Electronic Packaging

System-level package design issues to meet application requirements are introduced and modeling tools for analyzing electronic packages are applied. Materials and process selection guidelines are discussed for the manufacturing and reliability of packaged electronic products.

Application of theoretical principles to analysis designs. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5240G:

Adv Semiconductor Proc Lab

Design, layout, fabricate, and characterize microelectronic devices.

Analyze test results to verify performance to the predetermined specifications. Participate on a team project in which they will develop processes used to fabricate more advanced devices and/or circuits.

Required oral and written reports. May not be taken if credit has been previously earned for ECE 4244.

Credit Hour(s): 3

Lecture Hour(s): 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ECE 4234 (UG) OR ECE 4234 OR MSE 4234 (UG) OR MSE 4234

Corequisite(s):

ECE 5244:

Advanced Power Conversion Techniques

High-frequency resonant, quasi-resonant, and multi-resonant power conversion techniques; zero-voltage and zero-current switching techniques in pulse-width modulation converters and inverters. Pulse-width modulation and frequency modulation; non-linear analysis techniques for resonant and soft-switching converters and inverters. Power factor correction rectifiers and distributed power systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5254:

Power Converter Modeling and Control

Nonlinear modeling of power conversion circuit using discrete and average techniques analysis and design of voltage mode and current mode control; parallel module operation and system interactions; distributed power systems; time domain simulation and frequency domain measurement techniques. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5260:

Power Electronics System Integration

A broad overview of advanced power electronics technologies with an emphasis on multi-disciplinary aspects of integrated design.

Investigation of relationships between system application requirements and technological challenges in circuit topologies, power semiconductor devices, sensing and control, integrated packaging, and thermal management, and their impact on the system reliability and cost.

Introduction to the concept of integrated power electronics modules and their application in distributed power systems and motor drives. The

course is organized as a series of seminar lectures jointly taught by leading researchers from several universities and industry, via distance access.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5274:

Modeling and Control of Three-Phase PWM Converters

Power conversion principles for three-phase pulse-width modulation techniques, control and converters. Development of averaged models of three-phase rectifiers and inverters in stationary and rotating coordinates. Small-signal models in rotating coordinates and control design. Introduction of switching state vectors and different modulation schemes. Three-phase inverter and rectifier applications. Parallel and multi-level three-phase converters. Alternate years. Prerequisite or equivalent.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4224 (UG) OR ECE 4224

Corequisite(s):

ECE 5314:

Power System Operation and Control

A course dealing with modern power system operational and control problems and solution techniques. State estimation, contingency analysis, load-frequency control, and automatic generation control. Load flow analysis and external equivalents for steady-state operations. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4334 (UG) OR ECE 4334

Corequisite(s):

ECE 5324:

Power System Planning

A study of generation planning, bulk power supply systems, production costing analysis, and load forecasting. Dispersed generation. Electric power system reliability and stability. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4334 (UG) OR ECE 4334

Corequisite(s):

ECE 5334:

Electric Machines and Transients

Development of inductances, flux linkages, voltage equations, linear transformations, continuous simulation techniques, and machine models. Transients on transmission lines, transformers, and machines. Arcing and restriking phenomena. Lightning arresters and insulation coordination. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4314 (UG) OR ECE 4314

Corequisite(s):

ECE 5364:

Electric Energy and Environmental Systems

Role of electricity from fossil and nuclear fuels, and renewable resources. Impact of high voltage transmission lines. Health effects of electricity generation. Assessment of cogeneration cycles and demand side management. Emission control in the US electric utility industry. Evaluation of uncertainties in quantifying emissions impacts. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5374G:

Adv 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. System level cost benefit analysis. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5504 (CS 5504):**Computer Architecture**

Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, programming and interconnection network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4504 (UG) OR ECE 4504

Corequisite(s):

ECE 5505:**Testing and Fault-tolerant Computing**

Various topics on digital circuit testing and verification. 5505: digital circuit testing including simulation, test pattern generation, design for testability, built-in-self-test, and diagnosis. Graduate standing in ECE is required. 5506: circuit verification including two-level and multi-level circuit verification, sequential circuit verification, model-checking simulation-based verification, and ATPG-based verification. Graduate standing in ECE required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECPE 4505

Corequisite(s):

ECE 5506:**Testing and Fault-tolerant Computing**

Various topics on digital circuit testing and verification. 5505: digital circuit testing including simulation, test pattern generation, design for testability, built-in-self-test, and diagnosis. 5506: circuit verification including two-level and multi-level circuit verification, sequential circuit verification, model-checking simulation-based verification, and ATPG-based verification. Graduate standing in ECE required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECPE 4505

Corequisite(s):

ECE 5510 (CS 5510):**Multiprocessor Programming**

Principle and practice of multiprocessor programming. Illustration of multiprocessor programming principles through the classical mutual exclusion problem, correctness properties of concurrency (e.g., linearizability), shared memory properties (e.g. register constructions), and synchronization primitives for implementing concurrent data structures (e.g., consensus protocols). Illustration of multiprocessor programming practice through programming patterns such as spin locks, monitor locks, the work-stealing paradigm and barriers. Discussion of concurrent data structures (e.g., concurrent linked lists, queues, stacks, hash maps, skiplists) through synchronization patterns ranging from coarse-grained locking to fine-grained locking to lock-free structures, atomic synchronization primitives, elimination, and transactional memory. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4534 OR ECE 4550

Corequisite(s):

ECE 5514:**Design of Systems on a Chip**

Current state of the art in the system-level design of Systems on a Chip. The focus is in hardware, scheduling, and applications at the highest levels of design. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4514 (UG) OR ECE 4514

Corequisite(s):

ECE 5515:**Computer and Network Architectures**

5515: Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, program and network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors. 5516: Local area networks, wide area networks, and internets. Protocols and the ISO Open Systems Interconnect reference model. Design, analysis, and performance evaluation. Emphasis on data link, network, and transport protocols. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4504 OR CS 4504

Corequisite(s):

ECE 5516:

Computer and Network Architectures

5515: Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, program and network properties, principles of scalable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors. 5516: Local area networks, wide area networks, and internets. Protocols and the ISO Open Systems Interconnect reference model. Design, analysis, and performance evaluation. Emphasis on data link, network, and transport protocols. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4504 OR CS 4504

Corequisite(s):

ECE 5520:

Secure Hardware Design

Design and implementation of secure hardware at multiple levels of abstractions, covering cryptographic hardware primitives, cryptographic hardware primitives, cryptographic modules using passive attacks, active attacks, and cryptanalytic techniques. Countermeasures against reverse engineering. The course uses case studies and literature surveys to reflect on the state-of-the-art in secure hardware implementation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4514 (UG) OR ECE 4514

Corequisite(s):

ECE 5524:

Pattern Recognition

Computational methods for the identification and classification of objects. Feature extraction, feature-space representation, distance and similarity measures, decision rules. Supervised and unsupervised learning.

Statistical pattern recognition: multivariate random variables; Bayes and minimum-risk decision theory; probability of error; feature reduction and principal components analysis; parametric and nonparametric methods; clustering; hierarchical systems. Syntactic pattern recognition: review of automata and language theory; shape descriptors; syntactic recognition systems; grammatical inference and learning. Artificial neural networks as recognition systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

ECE 5530:

Configurable Computing

The design and implementation of high-performance computing machinery using configurable computing technology is studied. Contemporary computing methodologies are investigated, modeled, and constructed in laboratory exercises. Computational solutions are implemented by using field programmable gate arrays and adaptive computing devices.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4514 (UG), ECE 5504 (UG)) OR (ECE 4514, ECE 5504)

Corequisite(s):

ECE 5534:

Electronic Design Automation

This course introduces graduate students to the various design automation artifacts, algorithms, and methodologies. It includes system level design languages, abstractions, models of computation, high level synthesis, modeling and model transformations, and simulation based validation. The course deals with state of the art design practices. It requires a solid back-ground in computer architecture, digital design, and proficiency in programming and modeling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4514 (UG) OR ECE 4514

Corequisite(s):

ECE 5544:

Coding Theory

Use of codes to improve the reliability of transmission over noisy channels. Algebraic structure of codes. Includes error detecting and correcting codes. BCH Codes, Reed Solomon Codes, and convolutional codes and codes for checking arithmetic operations. II

Credit Hour(s): 3

349 Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 4714 (UG), MATH 4124 (UG)) OR (STAT 4714, MATH 4124)

Corequisite(s):

ECE 5545:

Advanced VLSI Design

Advanced concepts in CMOS-based digital system are studied. The topics include implementation of special purpose structures for complex digital systems, automation and verification of the design process, and design for testability (5545); and design techniques for low-power design, power dissipation estimation, and application of low-power techniques in the different levels of the design hierarchy (5546).

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4540 (UG) OR ECE 4540

Corequisite(s):

ECE 5546:

Advanced VLSI Design

Advanced concepts in CMOS-based digital system design are studied. The topics include implementation of special purpose structures for complex digital systems, automation and verification of the design process, and design for testability (5545); and design techniques for low-power techniques in the different levels of the design hierarchy (5546) design, power dissipation estimation, and application of low-power techniques in the different levels of the design hierarchy (5546).

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4540 (UG) OR ECE 4540

Corequisite(s):

ECE 5550G:

Advanced Real Time Systems

Introduction to real-time systems, real-time scheduling including multiprocessor scheduling, real-time operating systems (kernels), real-time communication, real-time programming languages, reliability and fault-tolerance, and real-time system requirements and design methods. Design, analysis, and implementation of real-time kernel mechanisms and real-time applications using kernels such as Linux and programming languages such as C (with POSIX primitives) and real-time Java. Prerequisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5554:

Computer Vision Sys

Gives a critical examination of current theories of computer vision. Explores both image analysis and scene analysis methods with the emphasis being given to scene analysis techniques. Emphasis is placed on the strategies that can be used rather than upon particular operators. Gives the design trade-offs associated with the various strategies. Draws analogies between computer vision techniques and the operations that are seemingly performed in human vision.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): CS 5534, CS 5814

ECE 5560 (CS 5560):

Network and Computer Security

Introduces both fundamental security principles as well as real-world applications of network and computer security. Covers a wide range of topics including authorization and access control, basic cryptography, authentication systems, e-commerce security, sensor network security, and legal and ethical issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4564 (UG) OR ECE 4564 OR CS 4254 (UG) OR CS 4254 OR ECE 5565 OR CS 5565 (UG)

Corequisite(s):

ECE 5564:

Wearable and Ubiquitous Computing

Issues in the design and use of wearable and ubiquitous computing systems. Topics covered include current research issues in system-level low power design, input/output devices, location and context-awareness, and networking. Students are expected to design, implement, and evaluate a wearable computing device or application.

Credit Hour(s): 3

350 Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4534 (UG) OR ECE 4550 (UG) OR ECE 4534 OR ECE 4550

Corequisite(s):

ECE 5565 (CS 5565):

Network Architecture and Protocols

5565: Principles and concepts of networking and protocols, with emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.

5566: Performance evaluation, design, and management of networks.

Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols. Network management architectures and protocols. Graduate standing in EE, ECE, CS, or IT is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

ECE 5566 (CS 5566):

Network Architecture and Protocols

5565: Principles and concepts of networking and protocols, with emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.

5566: Performance evaluation, design, and management of networks.

Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols. Network management architectures and protocols. Graduate standing in EE, ECE, CS or IT is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5565 (UG) OR ECE 5565

Corequisite(s):

ECE 5574G:

ADV Software Development CAE

Computer-aided engineering software that address the hierarchy of

engineering analysis, design, and decision evaluation is developed with state-of-the-art computer tools. Linear graph theory is applied to the modeling of physical networks. Operator overloading, dynamic polymorphism, graphical user interfaces, dynamic link libraries, and multiple threaded programs are considered. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5575:

Object-Oriented Software Devel

Use cases, class models, state models, interaction modeling, constraint modeling, message design, and concurrent and real-time systems. Students develop analysis documentation for an Engineering related project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4574 (UG) OR ECE 4574

Corequisite(s):

ECE 5576:

Object-Oriented Software Devel

Object-oriented design, including both logical and physical design. In logical design, rules related to class interfaces, containment, inheritance, and associations are covered along with design patterns. Physical design addresses components, levelized designs, and the application of generic programming concepts in design. Students develop design documentation for an engineering software project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4574 (UG) OR ECE 4574

Corequisite(s):

ECE 5585:

IT Security and Trust

Fundamental Internet and computer security principles and applications; legal and privacy issues, risk analysis, attack techniques, intrusion detection concepts, basic computer forensics, and system and application security hardening techniques. Pre-requisite: Graduate

Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5586:

IT Security and Trust

Advanced security and trust concepts and implementation in wired and wireless computer networks and computer systems; malware defenses, impact of channel fragility, node mobility, cooperative functionality, and resource constraints on security and trust at the different layers of the Internet protocol stack.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5585

Corequisite(s):

ECE 5604:

Computer-Aided Design and Analysis of Communication Systems

Simulation techniques for communication systems operating in random environments. Simulation models for stochastic signals and system components including coders, decoders, modulators, non-linear amplifiers, bit and carrier synchronizers, equalizers and receivers. Techniques for modeling time-varying channels. Monte Carlo simulation, semi-analytic simulation and variance reduction techniques applied to the analysis, design and performance evaluation of communication systems. Programming experience required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4624 (UG), ECE 4634 (UG), STAT 4714 (UG))
OR (ECE 4624, ECE 4634, STAT 4714)

Corequisite(s): ECE 5605

ECE 5605 (BMES 5525):

Stochastic Signals and Systems

Engineering applications of probability theory, random variables and random processes. Time and frequency response of linear systems to random inputs using both classical transform and modern state space techniques. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 4714 (UG) OR STAT 4714

Corequisite(s):

ECE 5606:

Stochastic Signals and Systems

Response of continuous and discrete time, linear and nonlinear systems to Gaussian and non-Gaussian random processes. Introduction to signal detection theory and optimal filtering (estimation) techniques. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5605 (UG) OR ECE 5605

Corequisite(s):

ECE 5634:

Information Theory

Transmission of information over noisy channels. Measures of information and transmission channel capacity. Use of codes to improve the reliability of such transmission. Mathematical theory of information. Transmission at rates above channel capacity. Includes linear codes, error detecting and correcting codes, Hamming codes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (STAT 4714 (UG), ECE 4634 (UG), ECE 5605 (UG))
OR (STAT 4714, ECE 4634, ECE 5604)

Corequisite(s):

ECE 5635:

Radar Systems Analysis and Design

5635: Theory and practice of radar systems used for detection, tracking, and location of targets. Covers measurement of range and velocity, pulse compression, design of radar transmitters, receivers, and antennas. 5636: Performance analysis of modern radar signal processing techniques. Topics include radar signal detection theory and optimal receiver analysis, target parameter estimation, pulse compression techniques, clutter reduction, and tracking. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5636:

Radar Systems Analysis and Design

5635: Theory and practice of radar systems used for detection, tracking, and location of targets. Covers measurement of range and velocity, pulse compression, design of radar transmitters, receivers, and antennas. 5636: Performance analysis of modern radar signal processing techniques. Topics include radar signal detection theory and optimal receiver analysis, target parameter estimation, pulse compression techniques, clutter reduction, and tracking. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (ECE 5605 (UG), ECE 5655 (UG)) OR (ECE 5605, ECE 5655)

Corequisite(s):

ECE 5654:

Digital Communications II: Advanced Theory and Analysis

Fundamentals of the theory, design, and analysis of modern digital communication systems. Representation of signal in digital form. Design and analysis of digital modulation formats and receivers using signal space techniques. Combining error correction techniques with digital modulation. Viterbi algorithm for maximum likelihood sequence estimation. Equalization and adaptive equalization. Fading channels and diversity techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): (ECE 4634 (UG), ECE 5605 (UG)) OR (ECE 4634, ECE 5605)

Corequisite(s):

ECE 5655:

Communication System Design

5655: Physical concepts and practical topics providing tools to calculate carrier-to-noise ratio in communication systems are discussed, including: noise processes, polarization topics, atmospheric propagation, receiver components, antennas, system calculation, and case studies. 5656: Advanced topics in digital satellite communications are discussed. These include multiple access, digital modulation, error correction coding, carrier phase, and symbol timing recovery. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): ECE 5105

ECE 5656:

Communication System Design

5655: Physical concepts and practical topics providing tools to calculate carrier-to-noise ratio in communication systems are discussed, including: noise processes, polarization topics, atmospheric propagation, receiver components, antennas, system calculation, and case studies. 5656: Advanced topics in digital satellite communications are discussed. These include multiple access, digital modulation, error correction coding, carrier phase, and symbol timing recovery. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4634 (UG) OR ECE 4634

Corequisite(s):

ECE 5660:

Spread Spectrum Communications

Major topics include: direct sequence and frequency hopping methods, synchronization, resistance to jamming, low probability of detection, spreading codes and their generation, system performance, RAKE receivers, Code Division Multiple Access, cellular CDMA applications, wireless LAN applications, as well as commercial and military applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4634 (UG), ECE 5605 (UG)) OR (ECE 4634, ECE 5605)

Corequisite(s):

ECE 5664:

Cellular Radio and Personal Communications

Fundamental theory and design of high capacity wireless communications systems. Topics include trunking, propagation, frequency reuse, modulation, coding, and equalization. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

353 Prerequisite(s): (ECE 4634 (UG), ECE 5605 (UG)) OR (ECE 4634,

ECE 5605)

Corequisite(s):

ECE 5665:

Telecommunications

5665: Basic concepts in electrical engineering. Waveforms, spectra bandwidth. Fourier series and transform. Decibels, SNR, BER. Analog and digital transmission and modulations. Wire and radio links, link budgets, SNR and BER. Pre: Graduate standing. 5666: Analog modulations, AM, FM. Digital Modulations, ASK, FSK, PSK, QAM. RRC filtering, digital transmissions. Multiplexing, multiple access. Error control, FEC, ARQ. Local area networks. Optical communication systems. Satellite communications, GPS.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5666:

Telecommunications

5666: Basic concepts in electrical engineering. Waveforms, spectra bandwidth. Fourier series and transform. Decibels, SNR, BER. Analog and digital transmissions and modulations. Wire and radio links, link budgets, SNR and BER. Pre: Graduate standing 5666: Analog modulations, AM, FM. Digital Modulations, FSK, PSK, QAM. RRC filtering, digital transmission. Multiplexing, multiple access. Error control, FEC, ARQ. Local area networks. Optical communication systems. Satellite communications, GPS.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5665

Corequisite(s):

ECE 5674:

Software Radios: Modern Radio Engineering

An introduction to software radios, devices that can be programmed to work with a variety of different radios. The course will cover the following topics: software radio architectures, existing software radio efforts, a review of basic principles, an analysis of receiver operation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 4624 (UG), ECE 4634 (UG)) OR (ECE 4624, ECE 4634)

Corequisite(s):

ECE 5714:

Robust Estimation and Filtering

An introduction to the analysis and design of maximum likelihood and robust estimators and filters. Maximum likelihood estimation theory: consistency, asymptotic efficiency, sufficiency. Robust estimation theory: qualitative robustness, breakdown point, influence function, change-of-variance function. Robust estimators: M-estimators, generalized M-estimators, high-breakdown estimators. Robust estimation of ARIMA models; Robust Kalman filter. Long memory processes: Hurst parameter estimation; parameter estimation of fractional ARIMA models.

Applications to image and speech processing, communications, radar systems, and electric power systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5605

Corequisite(s):

ECE 5724:

Neural and Fuzzy Systems

Introduction to various structures of artificial neural networks and fuzzy logic systems, as well as special learning mechanisms such as generalized back-propagation, clustering and genetic algorithms. Applications will be made to classification problems, binary associative memories, self-organizing maps, and nonlinear system modeling and control including on-line adaptation. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5704 (UG) OR ECE 5704

Corequisite(s):

ECE 5734 (AOE 5734) (ME 5584):

Convex Optimization

Recognizing and solving convex optimization problems. Convex sets, functions, and optimization problems. Least-squares, linear, and quadratic optimization. Geometric and semidefinite programming. Vector optimization. Duality theory. Convex relaxations. Approximation, fitting, and statistical estimation. Geometric problems. Control and trajectory planning. Pre: Graduate standing.

354 Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5744 (AOE 5744) (ME 5544):

Linear Systems Theory

Advanced introduction to the theory of time-varying and time-invariant linear systems represented by state equations; solutions of linear systems, uniform stability and other stability criteria, uniform observability and controllability, state feedback and observers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 OR ECE 4405 (UG) OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

ECE 5754 (AOE 5754) (ME 5554):

Applied Linear Systems

Develop an applied understanding of state-space representations for linear time invariant multi-input multi-output dynamic systems in both time domain and frequency domain. Introduction to modern state-space control methods; state feedback and output feedback. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 OR ECE 4624 OR ECE 4634 OR ME 4504 OR AOE 4004 OR ECE 4405 (UG) OR ECE 4624 (UG) OR ECE 4634 (UG) OR ME 4504 (UG) OR AOE 4004 (UG)

Corequisite(s):

ECE 5764 (AOE 5764) (ME 5564):

Applied Linear Control

Analysis and design of sampled-data systems, extraction of discrete-time dynamic models from experimental data, and implementation of dynamic compensators on digital processors. In-depth design experience with LQR optimal control and an introduction to Kalman filtering. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5554 OR ME 5544 OR AOE 5744 OR AOE 5754

Corequisite(s):

ECE 5774 (AOE 5774) (ME 5574):

Nonlinear Systems Theory

Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations: existence and uniqueness of solutions; continuous dependence on parameters; stability of equilibria and stability analysis techniques; input-to-state stability; input-output stability; nonlinear design techniques including input-state and input-output feedback linearization, backstepping, and sliding mode control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

ECE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ECE 5914:

Autonomous Systems Seminar

Weekly technical presentations from local and visiting scholars on current topics related to the theory, design and development, and application of autonomous vehicle systems. Pre-requisite: Graduate Standing required

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5944:

Seminar

To acquaint graduate students with recent and current research results and trends and to introduce researchers to students performing important work in Electrical and Computer Engineering. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5964:

Field Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ECE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ECE 6104:

Advanced Topics in Electromagnetics

Advanced topics of current interest in Electromagnetic Engineering.

Topics are selected from current technical literature. May be repeated for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s):

ECE 6114:

Advanced Analytical Electromagnetics

This course comprises PhD-level material covering exact and asymptotic analytical techniques for the solution of advanced electromagnetic problems involving wave propagation and scattering by finite and extended media inhomogeneities.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5106 (UG) OR ECE 5106

Corequisite(s):

ECE 6115:

Antenna Theory and Design I,II

6115: Antenna systems and arrays: antennas in systems, antenna synthesis array fundamentals, array excitation and mutual impedance, waveguide slot arrays, microstrip antennas, microstrip elements, microstrip planar and conformal arrays, numerical methods for antenna analysis, Method of Moments and FDTD, antenna measurements, phased arrays. 6116: Reflectors and aperture antennas: aperture theory, analytical and computer-based designs, reflector antenna fundamentals, numerical methods for reflector analysis, general formulation of GO, PO, GTD, PTD and UTD methods, Gaussian beams, reflector optic configurations, prime-symmetric, Gregorian, Cassegrain and prime-offset reflector systems, analysis of strut scattering, aperture blockage, spillover, G/T analysis, measuring and commissioning reflector systems,

reflector feed array, focal plane arrays, defocused arrays.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s): null null

ECE 6116:

Antenna Theory and Design I,II

6115: Antenna systems and arrays: antennas in systems, antenna synthesis, array fundamentals, array excitation and mutual impedance, waveguide slot arrays, microstrip antennas, microstrip elements, microstrip planar and conformal arrays, numerical methods for antenna analysis, Method of Moments and FDTD, antenna measurements, phased arrays. 6116: Reflectors and aperture antennas: aperture theory, analytical and computer-based designs, reflector antenna fundamentals, numerical methods for reflector analysis, general formulation of GO, PO, GTD, PTD and UTD methods, Gaussian beams, reflector optic configurations, prime-symmetric, Gregorian, Cassegrain and prime-offset reflector systems, analysis of strut scattering, aperture blockage, spillover, G/T analysis, measuring and commissioning reflector systems, reflector feed array, focal plane arrays, defocused arrays.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s): null null

ECE 6124:

Advanced Numerical Electromagnetics

A thorough coverage of numerical methods for electromagnetics, including topics on the foundations of function theory, Green's functions, mode-matching, and numerical expansion techniques in both the time and frequency domains. Emphasis will be placed on the method of moments and the finite element method, with development of the theoretical foundations of these methods. Alternate year course. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5106 (UG) OR ECE 5106

Corequisite(s):

ECE 6154:

Photonic Devices and Systems

Electromagnetic analysis of guided-wave optical devices and systems, including transmission properties of optical fibers, photonic crystal waveguides, grating structures, and coupled-wave components; soliton propagation in fibers; Erbium-doped and Raman fiber amplifiers; semiconductor light sources and photodetectors; wavelength-division multiplexed systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5105

Corequisite(s):

ECE 6204:

Advanced Topics in Electronics

Advanced topics of current interest in electronics engineering, with particular emphasis on microelectronics. Topics are selected from current technical literature to stress and reflect important potential areas in the electronic field. These topics include multichip modules, electronic packaging, microwave packaging, modeling simulation and evaluation of high speed devices, wideband characterization of electronic materials and multilayer structures, time and frequency domain measurement techniques. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ECE 6214:

Optoelectronic Devices

Principles of light generation and detection, operation, and design of state-of-the art optoelectronic and photonic devices. Advanced treatment of the operating principles of semiconductor optoelectronic devices with direct comparison to experimental data reported in the literature.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5200

Corequisite(s):

ECE 6304:

Advanced Topics in Power

Advanced topics of current interest in Electric Power Engineering. Topics are selected from current technical literature. Certain topics may be

repeated. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 6314:

Advanced Instrumentation in Power Systems

Role of advanced instrumentation in monitoring, control and protection applications in power systems. Effects and limitations of instrument transformers, signal conditioning circuits, analog to digital (A/D) converters and Digital Signal Processing (DSP) chips, time synchronization and sampling, output circuits and devices, and communication channels. Fast Fourier Transform (FFT), protection algorithms, phasor and frequency measurements.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5314

Corequisite(s):

ECE 6334:

Computational Methods in Power Engineering

This course is designed to introduce various linear and nonlinear program based optimization algorithms that are specially suited for the design, analysis and operation of electric power systems, power processing devices, machines, and transformers. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5324 (UG) OR ECE 5324

Corequisite(s):

ECE 6364:

Smart Grid Design & Operation

Introduction to smart grid technologies. Operating principles and models of smart grid components, including distributed energy sources and distribution feeder components. Communication infrastructure for smart grid operation. Advanced metering infrastructure and advanced control methods. Demand response and demand management. Distribution feeder analysis. Impact of smart grid component integration on distribution network operation. Smart grid reliability evaluation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5314 OR ECE 5314 (UG)

Corequisite(s):

ECE 6444:

Advanced Topics in Controls

Advanced topics of current interest in control theory taken from current research topics or technical publications. Graduate standing required.

May be repeated.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5404

Corequisite(s):

ECE 6504:

Advanced Topics in Computer Engineering

Advanced topics of current interest in computer engineering which are taken from current research topics and/or technical publications.

Prerequisites at 5000 level dependent on specific topics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 6514:

Applications of Automata Theory to Digital Design

Applications of theory of finite automata, push-down automata, and Turing machines to the design of digital machines. Emphasis will be on the computational capabilities of classes of finite and infinite automata and on the consequences for digital design. Theory of NP-completeness, description of NP complete problems in digital design, and the consequences for design processes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 3504 (UG), MATH 5454 (UG)) OR (ECE 3504, MATH 5454)

Corequisite(s):

Multimedia Networking

This course examines and explores recent advances in multimedia networking technologies. Major topics include multimedia compression and standards, quality of service (QoS) support mechanisms and protocols, performance analysis, network calculus, IP multicasting, Internet multimedia applications, and multimedia transport over wireless networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5565 (UG) OR ECE 5565

Corequisite(s):

ECE 6570:

Advanced Foundations of Networking

This course covers theoretical foundations that are necessary for advanced study of networking. It focuses on algorithm design and optimization techniques that are most commonly used to solve complex networking problems. Major topics include complexity analysis with applications to networking problems, design and proof of approximation algorithms, design of meta-heuristic algorithms, formulation techniques for network optimization, linear and non-linear optimization techniques with applications to networking, design of distributed algorithms with proof of convergence for networks systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5565 (UG) OR CS 5565 (UG) OR ECE 5565 OR CS 5565

Corequisite(s):

ECE 6604:

Advanced Topics in Communications

Advanced topics of current interest in communications, which are taken from publications and industrial information.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5654 OR ECE 5655

Corequisite(s):

ECE 6624:

Spectral Estimation & Modeling

An advanced introduction to the processing and modeling of random

discrete-time signals. Random time series, auto- and cross-correlation sequences and their generation, filtering of random sequences, Wiener filters, matched filters, modeling assumption errors, one-step predictors, rational modeling of random sequences, parametric and non-parametric spectral estimation. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 5605 (UG), ECE 4624 (UG)) OR (ECE 5605, ECE 4624)

Corequisite(s):

ECE 6634:

Multi-Channel Communications

In-depth study of modern multi-channel communications techniques, primarily multi-antenna systems (known as multiple input multiple output or MIMO) and Orthogonal Frequency Division Multiplexing (OFDM). Specifically the course examines multi-antenna techniques such as transmit and receive diversity, beamforming (including eigen-beamforming), and spatial multiplexing. Within the area of OFDM we examine modulation/demodulation, carrier bit loading, mitigating multipath, frequency-domain equalization, peak to average power reduction, and frequency offset mitigation. As time permits we will also investigate a third multi-channel technique known as multi-user scheduling or packet access networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 5605, ECE 5654

Corequisite(s):

ECE 6744 (AOE 6744) (ME 6544):

Linear Control Theory

Advanced introduction to the theory of optimal control of time-varying and time-invariant linear systems; Solutions to the linear-quadratic regulator, optimal filtering, and linear-quadratic-gaussian problems; Robustness analysis and techniques to enhance robustness of controllers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5544 OR ME 5554 OR AOE 5744 OR AOE 5754

Corequisite(s):

ECE 6774 (AOE 6774) (ME 6574):**Adaptive Control Systems**

Introduction to the theory and methodology used to design adaptive controllers for uncertain systems, addressing issues such as input constraints, disturbance rejection, partial measurements, and robustness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 5774, ECE 5744) OR (ME 5544, ME 5574) OR (AOE 5774, AOE 5744)

Corequisite(s):

ECE 6984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ECE 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENGINEERING EDUCATION

Stephanie Adams, Head

Professors: Stephanie Adams; Vinod Lohani; Donna Riley; Bevelee Watford;

Associate Professors: Richard Goff; Elizabeth McNair; Marie Paretti; Kenneth Reid; Christopher Williams;

Assistant Professors: David Knight; Holly Matusovich;

Graduate Program Contact: matushm@vt.edu

Graduate Site: <http://www.enge.vt.edu/Graduate/graduateprograms.html>

Graduate Student Manual:

<http://www.enge.vt.edu/Graduate/graduateprograms.html>

The Engineering Education PhD program incorporates theory and practice so that its students are prepared to be teachers and scholars in the emerging field of engineering education. We incorporate theory with applied practice to prepare students for a wide range of careers:

Engineering policy Corporate training management University assessment University administration Education in academia and K-12 Research and scholarship Graduates of the doctoral program will be able to conduct and direct research in engineering education, develop, review, and critique effective research designs, effectively teach engineering subjects, design and assess engineering courses, and address critical issues facing engineering education. The Engineering Education Graduate Program also offers a 13-credit Graduate Certificate. Course offerings overlap significantly with those of the Engineering Education PhD and the Graduate School's Professoriate Certificate. Our Mission: to support the critical role of engineering in societal and global development to improve the synergistic role of education research, teaching, practice, and advising in engineering to promote the value of and need for educating and developing engineering professionals

SPECIAL FACILITIES

The Department of Engineering Education has cultivated core research strengths in professional skills such as interdisciplinarity, communication, collaboration, design education, motivation, global issues, and first year courses (particularly learning technologies). Retention, diversity, and assessment are important foundational concepts in the field of engineering education; as such, they are elements of all our projects.

Design, Research, and Education for Additive Manufacturing Systems Lab (DREAMS Lab)

DREAMS Lab members are driven by a passion to empower future designers through the discovery of new tools, techniques, and technologies for improving design practice and through a better understanding of how design education affects learning and practice. Engineering Education lab members strive to improve design pedagogy by exploring new instructional methods and technologies, exploring students' design cognition and behavior, and by linking existing design methodologies to educational practice. Dr. Chris Williams, Director

LabVIEW Enabled Watershed Assessment System Lab (LEWAS Lab)

Supported by the National Science Foundation, LEWAS integrates hardware and software components to develop learning modules and opportunities for water sustainability education and research. LEWAS brings real-time water data using wireless technology from the Webb branch of Stroubles creek, an on-campus stream, into our first year engineering class for water sustainability education. Integration of LEWAS into upper level engineering courses is in progress. Dr. Vinod Lohani, Director

NSF Center for e-Design

The Center for e-Design is a nucleus for the creation and dissemination of a systematic body of knowledge in intelligent design facilitation and product realization. The NSF I/UCRC Center is a joint research coalition

comprised of many universities, businesses and organizations. Our research objectives are to develop and test technologies, to provide a testbed to verify and validate the performance of vendors' software, and to nurture and cultivate a new breed of engineers and business leaders. Dr. Richard Goff, Director

Technology, Open Organizing, & Learning Sciences Laboratory (toolsLAB)

Led by Engineering Education Assistant Professor Aditya Johri, toolsLAB is funded in part by the National Science Foundation (IIS, EEC), corporate partners, and ICTAS and Engineering Education at Virginia Tech. We examine how digital tools afford new ways of reorganizing knowledge sharing and knowledge building and their impact on learning. We design tools and technologies to prepare future engineers and to support their work practices. Dr. Aditya Johri, Director

Virginia Tech Engineering Communications Center (VTECC)

VTECC integrates the professional and the technical to create a new kind of engineer. The Center 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. Co-Directors: Dr. Lisa McNair & Dr. Marie Parette

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (79.0)

GRE

PhD students must take a minimum of 90 total credits beyond the Bachelor's degree, submitted on a program of study subject to approval by the student's advisory committee. Curricular Requirements: Dissertation: 30 credits min. Quantitative Research Methods: 3 credits Qualitative Research Methods: 3 credits Education: 9 credits Engineering Education core courses: 12 credits Engineering Concentration: 15 credits Electives: 6 credits Required Milestones and Examinations: Qualifying Examination Preliminary Examination PhD Research Proposal Progress Report Final Examination (Defense) Additional Information: At least 9 credits (ENGE or non-ENGE) will be at the 6000 level relevant to the student's research. Up to 30 credits from a Master's degree may be counted toward the PhD at the discretion of the student's advisory committee. Students must enroll in ENGE 5704: Engineering Education Graduate Seminar (1 credit) each semester. More detailed information regarding degree requirements is available in the Engineering Education Graduate Manual.

GRADUATE COURSES (ENGE)

ENGE 5014:

Foundations of Engineering Education

This course addresses foundational principles of engineering education through relevant theories of teaching and learning, curriculum development, assessment, and student development. Broad categories of engineering courses (laboratories, design courses, and lectures) are examined with respect to course design, learning objectives, instructional methods, and assessment and accreditation. Students will learn to apply research- and theory-based educational methods to develop course materials and assess learning consistent with engineering accreditation standards. Graduate standing and completion of 6 credits of ENGE or related coursework with consent of instructor required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5024:

Design in Engineering Education and Practice

This course is focused on preparing future engineering faculty members and practitioners to teach engineering design as well as how to function more effectively in industry design environments. Material related to theories of student learning and appropriate pedagogical approaches to teaching an open-ended subject such as engineering design will be included. Student mentoring of design teams will be a key feature. Guest speakers from industry, academia, and government organizations will supplement the course work. Graduate standing in any department at Virginia Tech required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5334:

Evaluating Engineering Communication Assignments

Explore a variety of applicable strategies they can use to help engineering students in their courses become stronger communicators. Topics include developing concrete criteria for evaluating, identifying weaknesses, deciding where and how to intervene, developing effective written and oral responses to help students improve, and locating

additional resources to help engineering student communication.

Graduate standing in an engineering department at Virginia Tech required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5404:

Assessment Techniques in Engineering Education

Assessment issues and skills important for engineering faculty or staff members at a college or university are addressed, including the strengths and weaknesses of a variety of quantitative and qualitative assessment strategies. Assessment is framed as an integrated part of course design, and ABET engineering accreditation criteria and procedures are discussed in-depth. Students will design and conduct an assessment in engineering course and learn important considerations in coordinating department or college resources in preparation for an ABET review.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ENGE 5014

Corequisite(s):

ENGE 5504:

Practicum in the Engineering Classroom

Preparation for and practical experience as a teacher in the engineering classroom. Student must have primary responsibility for a class, workshop, or laboratory. Design and presentation of plans, lectures, workshops, and laboratories in the engineering classroom. Discussion, review, and evaluation of performance by senior faculty and discussion with peer group. May be repeated. Graduate standing, and completion of 6 credits of ENGE or related coursework with consent of instructor required.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5604:

Engineering Education Research Methods

This course introduces methods and considerations specific to research in engineering education. Quantitative, qualitative and mixed methods are discussed as well as measures of research quality. Students will learn to design and critique engineering education research quality. Students will learn to design and critique engineering education research that addresses standards of rigor and quality. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5704:

Engineering Education Graduate Seminar

This course is designed to bring contemporary issues in engineering education research into the classroom. Experts from academia, industry, and the corporate world will be invited to make presentations on engineering education research issues including recruitment of minorities, retention issues, technology integration into engineering curricula, distance learning, engineering content into K-12 curriculum, learning theories, engineering education policy issues, etc. In addition, graduate school procedures relevant to various graduate programs in the EngE department will be explained. Altogether the course will include a minimum of 11 seminar presentations. Students will learn to critique engineering education research presentations and will demonstrate knowledge of contemporary issues in engineering education research. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5714:

Topics in Engineering Education Research Methods

Topics in engineering education research methods. Explorations of current and emerging methods used in engineering education research. Adapting methods used in other fields for engineering education audiences. Implications for future research. May be repeated up to three times with different topics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ENGE 5604

Corequisite(s):

ENGE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ENGE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENGE 6604:

Advanced Engineering Research Methods

This course focuses on research issues and methods specific to engineering disciplines, including engineering education. Quantitative, qualitative, experimental, and theoretical research methods are discussed as well as reliability, validity, and other measures of quality. Students will learn to design and critique engineering research in their disciplines and have the opportunity to write an original research proposal, with literature review, consistent with departmental requirements. Collaboration and variations in disciplinary standards are also discussed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ENGE 5604

Corequisite(s):

ENGE 6704:

Topics in Engineering Pedagogies

Topics in pedagogical theories and practices in engineering. Historical and contemporary perspectives. Explorations of specific pedagogical theories and/or approaches to specific topics. Emphasis on curriculum design. May be repeated up to three times with different topics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ENGE 5014

Corequisite(s):

ENGE 6714:

Topics in Engineering Education Research and Practice

Topics in engineering education. Explorations of current and emerging topics relevant to engineering education research and professional practice. Historical and contemporary perspectives on current conversations within engineering education. Implications for research and practice. May be repeated up to three times with different topics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ENGE 5014, ENGE 5604

Corequisite(s):

ENGE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENGE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENGINEERING MECHANICS

Stefan Duma, Head
Scott Case, Program Director

Emeriti Faculty: John Grant; Michael Hyer;

Professors: Romesh Batra; Richard Benson; Scott Case; Mark Cramer; David Dillard; Norman Dowling; John Duke; Muhammad Hajj; John Lesko; Roop Mahajan; Steven McKnight; Saad Ragab; Mahendra Singh;

Associate Professors: Marwan Al-Haik; Raffaella De Vita; Scott Hendricks; Shane Ross; John Socha; Mark Stremler; Surot Thangjitham;

Assistant Professors: Nicole Abaid; Jonathan Boreyko; James Hanna; Sunghwan Jung; Anne Staples;

Affiliated Faculty: Rafael Davalos; Tomonari Furukawa; Scott Huxtable; Rakesh Kapania; Rolf Mueller; Amrinder Nain; Maury Nussbaum; Alexey Onufriev; Robert Parker; Mayuresh Patil; Gary Seidel; Saied Taheri; Pablo Tarazaga; Costin Untaroiu; Leigh Winfrey; Craig Woolsey; Roe Yoon;

Clifton C. Garvin Professor: Romesh Batra;

Adhesive & Sealant Science Professor: David Dillard;

Frank J. Maher Professor: Norman Dowling;

Associate Dean for Research and Graduate Studies: John Lesko;

ICTAS Director, Lewis A. Hester Chair in Engineering: Roop Mahajan;

Preston Wade Professor of Engineering: Mahendra Singh;

Dean of Engineering, Paul & Dorothea Torgersen Chair: Richard Benson;

Vice President for National Capital Region: Steven McKnight;

N. Waldo Harrison Professor Emeritus: Michael Hyer;

Kevin P. Granata Faculty Fellow Emeritus: John Grant;

Norris and Laura Mitchell Professor of Aerospace Engineering: Rakesh Kapania;

Nicholas T. Camicia Professor: Roe Yoon;

L.S. Randolph Professor: Robert Parker;

Graduate Contact: lisas@vt.edu

Graduate Site: <http://www.esm.vt.edu/graduate>

The Department of Engineering Science and Mechanics provides a strong foundation and a sturdy framework for the discovery, development, transfer, and implementation of new knowledge in the areas of mechanics of materials and material systems, fluid mechanics, dynamics and vibration, biomechanics, and computational methods. The department is fully committed to providing an environment for strong undergraduate and graduate education that emphasizes fundamental understanding, high-quality teaching, frontier-level research, innovation, and service to the professional mechanics community. Instilling ESM graduates with a highly flexible professional perspective enables them to pursue successful careers in a variety of engineering industries, in research environments, and in higher education. Indeed, ESM graduates now populate prominent engineering departments across the nation and are transmitting the values of their engineering science training to new generations of students. Our graduates also serve as science and

technology advisors to local, regional, and federal governmental organizations; hold leadership positions in professional societies; and are active participants in public discourse on the role and value of engineering science in relation to the research and educational competitiveness of the Commonwealth of Virginia and our nation.

SPECIAL FACILITIES

The ESM Department has allocated ~ 40,000 sq ft. for the following laboratories: Adhesion Mechanics Laboratory Biologically Inspired Fluid Laboratory Biomechanics Laboratory Cardiovascular Hemodynamics Laboratory Comparative Biomechanics Laboratory Composite Fabrication Laboratory Creep Laboratory Damage Science and Mechanics Laboratory Fluid Mechanics Laboratory Georgia Pacific Adhesion Science Laboratory Kevin P. Granata Biomechanics Laboratory Laboratory for Scientific Visual Analysis Mechanics of Soft Biological System Laboratory Multi-Phase Flow Laboratory Multiphysics Research Group Nonlinear/Dynamic/Vibration Research Laboratory Servohydraulic Laboratory

Adhesion Mechanics Laboratory

Mechanical, electrical, and optical techniques are employed to characterize adhesives and determine performance of adhesively bonded joints and structures. Fracture mechanics principles are widely used to better understand joint capabilities. Special equipment includes a 10,000 lb. MTS servohydraulic test frame used for fatigue testing, a 20,000 lb. Instron test frame with an assortment of load cells for conducting strength and fracture tests, two drop towers for impact studies, a high speed camera, an environmental chamber for use in the load frames, a Nikon microscope, a micromanipulator used for testing coating adhesion, a Veeco interferometric profilometer, and computers and work stations used for finite element analysis.

Bio-Inspired Fluid Laboratory

Major experimental equipment in the laboratory include: A high-speed camera (Redlake N3) Programmable a linear stage (Velmex, Xslide) to actuate the linear motion. Its maximum load is 2.3 kg with the accuracy of a 0.001-inch resolution A high resolution digital camera (Canon 50D) Inverted Microscope (Leica)

Biomechanics Laboratory

Microscopes, micromanipulation systems, and microsurgery, all mounted on a vibration isolation table for making microscopic force and displacement measurements in the vestibular system of the inner ear. Micropipette and Microforge manufacturing capability. Hematology microscope and blood examination equipment. Implantable blood flow measurement equipment. Blood viscosity measurement. Silicon Graphic Indigo 2 work station with associated software to carry out FEA analysis along with several personal computers.

Cardiovascular Hemodynamics Laboratory

Contact: Professor Demetri Telionis Phone: (540) 231-7492

Comparative Biomechanics Laboratory

Major experimental equipment in the laboratory include: Fluorescent Dissecting Microscope Custom Built Dynamic Mechanical Analyzers

Fume Hood Distilled Water

Complex Systems Laboratory

Dr. Abaid previous research has focused on developing network-based mathematical models of schooling behavior in fish and validating such models using behavioral experiment on zebrafish and golden shiner minnows with a variety of robotic and computer-animated stimuli. Dr. Abaid's research interest include bioinspired mathematical modeling, complex systems, controls, data mining, distributed systems, dynamical systems, mechatronics, network theory, synchronization.

Composites Fabrication Laboratory

The Composites Fabrication Laboratory provides the following equipment for processing composite materials: Seventy five ton cauum hot press with eighteen inch by eighteen inch steel platens of temperatures to 800 degrees F. One hundred ton compression hot press. Fifty ton hydraulic compression hot press with sixteen inch by sixteen inch platens. Twenty five ton pneumatic compression hot press with sixteen inch by sixteen inch platens. Clean room facility for composite processing. Fume hood. Large Bally walk in freezer for material storage. K. O. Lee slicer wet saw unit. A variety of steel modls for processing composite materials.

Creep Laboratory

This laboratory contains several lever-arm creep frames, a four-station stepper motor creep frame, and a 72-station pneumatic creep frame. Each is equipped with an oven for conducting tests at elevated temperatures. These units are used to measure the time dependent response of polymeric materials, including adhesives, adhesively bonded joints, and composites. Effects of time, temperature, and stress level are collected for creep, relaxation, and creep rupture loading situations.

Damage Science and Mechanics Laboratory

Damage science and mechanics is concerned with understanding what causes damage, how it develops, and how to evaluate the effects it will have on performance of components. Understanding damage and its effects is an essential element of sustainment of critical structures and systems. In our DSM Lab at Virginia Tech, we focus our efforts on developing methods for detecting and monitoring damage to support the development of models for predicting performance of degraded components or for input to fully developed models used for prognosis or maintenance decision-making. Areas of emphasis at present include damage development prior to macro crack formation in metal alloys and service-induced damage development in advanced composite materials.

Fluid Mechanics Laboratory

This lab contains a water tunnel, a wind tunnel and a towing tank. Such facilities are used to test wing sections, hydrofoils, ship hulls and other devices employed in fluid machinery. Laser-Doppler velocimeters, hot wire anemometers and pressure transducers are among the instruments employed.

Georgia Pacific Adhesion Science Laboratory

A complete thermal analysis system is used to measure the effects of temperature on polymer behavior. Modern TA Instruments units include a modulated DSC (differential scanning calorimeter), DMA (dynamic mechanical analyzer), and modulated TGA (thermogravimetric analyzer). Conditioning chambers for looking at the effects of environment on polymer and adhesively bonded joint performance are also located in this area. A fume hood, refrigerator, centrifuge, vacuum system, and several ovens are used for processing, bonding, and curing specimens.

Kevin P. Granata Biomechanics Laboratory

Our mission is to investigate the dynamics and neuromuscular control of human movement, and to train scientists to become leaders in the field of musculoskeletal biomechanics.

Laboratory for Computational Biomechanics and Fluid Dynamics

The research at the Laboratory for Computational Biomechanics and Fluid Dynamics is focused on two main areas: computational fluid dynamics. A unifying theme is the use of multiscale methods to create computational models and algorithms that exploit the inherent properties of systems to reduce the spatial and temporal complexity of a given problem.

Laboratory for Scientific Visual Analysis

Contact Ron Kriz, Lab Director at: rkriz@vt.edu for further information.

Mechanics of Soft Biological System Laboratory

Major experimental equipment in the laboratory include: Instron ElectroPuls dynamical test system (dynamic capacity= 225 lbf and static capacity= 160 lbf). Photron Ultima APX-RS camera, frame rate: 60 to 250,000 fps, basic resolution: 1024 x 1024 at 3000 fps Zeiss Stereoscope Stemi 2000C Maytag Refrigerator Nikon Camera D500 Various dissecting tools, micrometers, lenses, a digital camera, etc.

Multi-Phase Flow Laboratory

Contact: Professor Demetri Telionis Phone: (540) 231-7492

Multiphysics Research Group

The Multiphysics Research Group (MuRG) investigates transport phenomena and reaction chemistry at the nano, micro and continuum scales using both numerical and experimental methods. The group specializes in techniques such as lattice Boltzmann method, Molecular Dynamics, Stokesian Particle Dynamics amongst others. In addition to theoretical and numerical studies, the group also characterizes materials experimentally using advanced diagnostics such as the Scanning Electron Microscopy, Transmission Electron Microscopy, X-ray Photoelectron Spectroscopy and Laser Induced Fluorescence, to name a few. Current research focuses on microscale mixing using field effects (eg. magnetic or electroosmotic forces), growth models for carbon nanotubes and their characterization, mass and ion transport through carbon nanotubes and heat transfer at the nanoscale. Efforts such as these are indispensable for the advancement of research and development at the frontier of science.

Nanotechnology and Nanomechanics

The Nanomaterials and Nanomechanics Laboratory research effort is concentrated in the areas of nanomaterials synthesis, characterization and modeling. The main focus for these activities is to develop novel materials systems (primarily composites) to meet multi-functionalities by incorporating both nanoscale and micro/macroscale structures together as a hybrid systems that benefit from the superior properties of the nanomaterials and the affordability of the micro/macroscale conventional materials. The research spans over several synthesis methods such as graphitic structures by design (GSD) to grow different species of carbon nanomaterials (graphene, graphite and carbon nanotubes), chemical vapor deposition (CVD), physical vapor deposition (PVD) of metallic and ceramic thin films, wet chemistry and microwave assisted synthesis of ceramic nanoparticles and inorganic nanotubes. The microstructural characterization techniques include electron microscopy (TEM, SEM and AFM), X-ray diffraction and texture analysis, electron backscatter diffraction (EBSD) and spectroscopy techniques including Raman and spectrophotometry. The mechanical testing capabilities expand over several scales. Beside the standard ASTM mechanical tests at the macroscale, the group maintains unique capabilities of conducting several mechanical tests at the nanoscale (nanoindentation, nanoimaging, nanoscratch, nanofriction, nanocreeep) at temperatures ranging between 25-750 C and at wet or dry environments. The computational methods utilized by the group include finite element analysis (ABAQUS, LS-DYNA), neural networks implicit models, numerical optimization, Molecular Dynamics and Monte Carlo simulations.

Nonlinear Dynamics/Vibration Research Laboratory

In this laboratory, analog, digital, analytical, and experimental investigations are conducted. The facilities available include analog computers, digital computers, workstations, an optical measurement system, electrodynamic shakers, transducers, and signal analyzers among other things. The models used in the laboratory serve as analogues of several systems and the work conducted in this laboratory is pertinent to the design, identification, dynamics and control of aircraft, space structures, and other systems. Theoretical and experimental investigations are also being conducted to study the nonlinear dynamics of ships and submarines, especially complicated motions, such as capsizing. Experiments with ship models are carried out in the towing tank, which is equipped with a wavemaker, a custom made measuring system, wave probes, and a signal analyzer. Ling Dynamic Systems 1000-lb reaction-mass shaker Unholtz-Dickie 250-lb table shaker MB Dynamics 50-lb and 100-lb modal shakers MOOG six degrees-of-freedom testing platform DADS mechanical simulation software dSPACE digital control platform Accelerometers and impact hammers Strain gages and signal conditioners

Servo-hydraulic Material Testing Laboratory

The Servo-hydraulic Materials Testing Laboratory, located in 107 Hancock Hall, on the Virginia Tech campus in Blacksburg, Virginia, consists of nine hydraulically-operated load frames which are under the direction of four different departments within the College of Engineering, one research center within the department of Mechanical Engineering, and one research group within the department of Engineering Science and Mechanics. They are the departments of Engineering Science and Mechanics (ESM), Materials Science and Engineering (MSE), Mechanical Engineering (ME), and Aerospace and Ocean Engineering (AOE), the Center for Intelligent Material Systems and Structures (CIMSS), and the Materials Response Group (MRG). In addition, the U.S.A.F. at Wright-Patterson A.F.B. is temporarily utilizing laboratory space for one of their proprietary testing machines, making this laboratory an interdisciplinary materials testing facility.

Soft Mechanics Laboratory

The mechanics of soft structures provide a great framework to study problems ranging from flexible devices to biological interfaces. The ability for these structures is to accommodate large stresses and deformations via dramatic elastic instabilities aid in the design of advanced, responsive materials. Our group is interested in using elasticity, soft materials, and instabilities such as snap-buckling, crumpling, wrinkling, and folding to study the fundamental mechanics of soft or slender structures. Using this knowledge, we will generate structural responsiveness and impact properties such as adhesion, optics, and flow at surfaces or within devices.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (79.0), (0.0)

MS thesis option : student must take 21-24 course credit hours and 6-9 thesis credit hours for a minimum total of 30 credit hours. MS non-thesis option : student must take 30 course credit hours and a final oral examination.

MEng Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

MEng option: student must take 27 credit hours and a three-credit paper

on an engineering project.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Ph.D. : student must take 44-55 course credit hours and 36-45 research and dissertation credit hours for a minimum total of 90 credit hours. Student must pass qualifying, preliminary and dissertation proposal and defense exams.

GRADUATE COURSES (ESM)

ESM 5014:

Introduction to Continuum Mechanics

Analysis of stress and deformation at a point. Development of the basic equations of a continuous medium by applying the basic laws of conservation of mass, linear momentum, moment of momentum and those of thermodynamics. Study of constitutive axioms and constitutive relations for fluids and solids. Specialization of the field equations to simple boundary-value problems of solid mechanics and fluid mechanics with simple solutions. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 3015

Corequisite(s):

ESM 5044G:

Advanced 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. Environmentally induced stresses. Computerized implementation and design. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5064:

Structural Optimization

Structural optimization via calculus of variations. Application of techniques of mathematical programming to optimize trusses, beams, frames, columns, and other structures. Sensitivity calculation of structural response. Approximation techniques and dual and optimality criteria methods. A background in optimization is necessary. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5074:

Mechanics of Laminated Composite Structures

Constitutive relations. Classical laminated composite beams, plates, and shells. Theories and boundary conditions. Boundary value problems and solutions for static loads, buckling, and vibrations. Higher ordered theories including shearing deformation and normal stress. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4044, ESM 5014, MATH 4544, MATH 4564

Corequisite(s):

ESM 5124:

Theory of Elasticity

Equations of equilibrium, strain-displacement, compatibility, and constitutive equations in terms of Airy and complex potential stress functions applied to plane engineering boundary value problems including beams, disks, thick-walled tubes, perforated plates, and various stress raiser problems. Three-dimensional applications to torsion, bending, semi-infinite solids. Galerkin vector, Papkovich functions. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5014, MATH 4426

Corequisite(s):

ESM 5134:

Advanced Mechanics of Materials

Thick-walled cylinders and spinning disks, introduction to thin plates and shells, beams on elastic foundations, energy methods, torsion of thin-

beam-columns and ties, introduction to plastic collapse, introductory applied elasticity. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5144 (MSE 5144):

Deformation and Fracture of Materials

Deformation and fracture of engineering materials is considered in the context of solid mechanics and engineering methods for predicting strength and life. Topics include plasticity, failure criteria, fracture mechanics, crack growth, strain-based fatigue, and creep.

Microstructure-property relationships are discussed. Laboratory demonstrations of behavior in mechanical tests are included. Partially duplicates material in ESM 4024 and both should not be taken. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 3054

Corequisite(s):

ESM 5174:

Polymer Viscoelasticity

Constitutive models of linear viscoelastic materials, experimental aspects, polymer response to mechanical and electrical inputs, solid state NMR and microwave interactions with polymers, free volume theories, temperature and environmental effects on polymers, physical aging of glasses. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5224 (BMES 5124):

Advanced 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5234:

Reliability Methods in Structures and Mechanics

Theory of structural reliability; reliability based designs, safety index, linear and nonlinear design equations, load and resistance factors, Level I, II and III formats, code formulations; systems reliability, bounds on reliability.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4614 OR STAT 4706

Corequisite(s):

ESM 5245G:

Mechanics Animal Locomotion

The mechanical and biological principles of animal locomotion. Comparative examples from locomotor modes including walking, running, jumping, climbing, burrowing, and crawling used to extract general principles underlying kinematics, dynamics, energetics, and control. Terrestrial locomotion-based bio-inspired design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5246G:

Mechanics Animal Locomotion

The mechanical and biological principles of animal locomotion. Locomotor modes including active and gliding flight, swimming, jetting, and running on water, examined from perspectives of kinematics, dynamics, energetics, and control. Engineering design inspired by fluids-based biological locomotion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Mechanics of Adhesive Bonding and Interfaces

Principles of mechanics applied to adhesively bonded joints and interfaces, overview of adhesion technology, stress analysis of adhesive joints, stresses in bimaterial systems and interfaces, failure mechanisms and fracture, thermodynamic and observed toughnesses, time dependence and durability, design. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 3054 OR ESM 5654

Corequisite(s):

ESM 5304 (AOE 5034):

Mechanical and Structural Vibrations

Free and forced vibration of single-degree-of-freedom systems, multi-degree-of-freedom systems, continuous systems including strings, rods, bars, and beams. Natural frequencies and modes. Rigid Body modes. Proportional and nonproportional damping. Response to harmonic, periodic, and nonperiodic excitations. Solutions by modal analysis, direct integration and Fourier Series. Approximate methods including assumed modes and the Rayleigh-Ritz method. Advanced topics chosen by instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5305:

Biomechanics of the Cardiovascular System

5305: Mechanics of the heart, arterial blood vessels and microcirculation; history of the circulation; anatomy and physiology of the heart; mechanics of cardiac contraction; cardiac fluid mechanics; work, energy, efficiency of cardiac function. 5306: Rheology of blood; hematology; elasticity of blood vessel walls; transport processes; control of the circulation; mathematical analysis of pulsatile blood flow and pulse-wave propagation through small arteries, capillary beds and extra-corporeal devices.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4106

Corequisite(s):

ESM 5306:

Biomechanics of the Cardiovascular System

5305: Mechanics of the heart, arterial blood vessels and microcirculation; history of the circulation; anatomy and physiology of the heart; mechanics of cardiac contraction; cardiac fluid mechanics; work, energy, efficiency of cardiac function. 5306: Rheology of blood; hematology; elasticity of blood vessel walls; transport processes; control of the circulation; mathematical analysis of pulsatile blood flow and pulse-wave propagation through small arteries, capillary beds and extra-corporeal devices.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4106

Corequisite(s):

ESM 5314:

Intermediate Dynamics

Review of Newtonian mechanics, fundamental concepts of analytical mechanics, Hamilton's principle, Lagrange's equations, rigid-body dynamics, Euler's equations, gyroscopic principles, definitions of stability, geometric theory (phase-plane trajectories), limit cycles, state-space analysis, Routh-Hurwitz criterion, Liapunov direct method. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5324:

Random Vibrations in Structures I

Stationary and nonstationary random processes in random vibrations of structures; ergodicity and measurements of random loads, FFT, autocorrelation and power spectral density functions; response functions; vibrations of single- and multi-degrees of freedom mechanical and structural systems subjected to random loads; response threshold crossing rates, peak distributions, and first passage problem; application to cumulative damage potential and structural reliability assessments. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ESM 5304 OR ESM 4074), (ESM 4614 OR STAT 4706)

Corequisite(s):

ESM 5344:**Wave Propagation in Solids**

Formulation and solution of propagation problems in infinite, isotropic media. Solution of the reflection-refraction problem at plane interfaces.

Discussion of Rayleigh, Love, and general surface waves. General treatment of wave propagation in infinite anisotropic media. Wave diffraction phenomena. Waves in bounded media: bars and plates. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5014

Corequisite(s):

ESM 5354:**Mathematical Modeling of Biological Dynamics**

This multidisciplinary course focuses on how mathematical models of biological systems can be developed and how the response of these systems to stimuli and aberrations can be studied. The course discusses various biological subjects, e.g., drug inhibition, population dynamics and epidemiology using biological models. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5405:**Clinical Internship in Biomedical Engineering**

Off-campus student exposure and participation in a planned clinical experience for those preparing to enter the field of Biomedical Engineering. On-campus lecture/lab/demonstration sessions to supplement the clinical experience. Students are placed in selected hospitals throughout the local area during two summer sessions under close supervision of a university staff member and cooperating medical personnel.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ESM 5406:**Clinical Internship in Biomedical Engineering**

Off-campus student exposure and participation in a planned clinical experience for those preparing to enter the field of Biomedical Engineering. On-campus lecture/lab/demonstration sessions to supplement the clinical experience. Students are placed in selected hospitals throughout the local area during two summer sessions under close supervision of a university staff member and cooperating medical personnel.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ESM 5414:**Nonlinear Systems**

Dynamics of conservative and nonconservative systems; phase planes; local and global stability; damping mechanisms; self-excited oscillators. Forced oscillations of one-degree-of-freedom systems; primary, secondary, and multiple resonances; period-multiplying bifurcations; strange attractors; chaos. Parametric excitations; Floquet theory; influence of damping and nonlinearity. Multi-degree-of-freedom systems; concepts of internal and external resonances; Hopf bifurcation.

Applications to continuous systems; strings, beams, plates, and shells. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5754, ESM 5304

Corequisite(s):

ESM 5444:**Dynamic Stability of Structures**

Modern structural stability analysis; static and dynamic instability; conservative and nonconservative systems; multiple loads; and Liapunov stability analysis. Applications to columns, rotating shafts, pipes conveying fluid, and airplane panels. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4074 OR AOE 3034

Corequisite(s):

ESM 5454 (AOE 5054):**Elastic Stability**

Stability of elastic structural components under conservative loads; precise definitions of stability; energy approaches; Rayleigh-Ritz and Galerkin methods; and applications to column, arches, plates, and shells. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3404 OR AOE 3124

Corequisite(s):

ESM 5464:

Structural Dynamics and Earthquake Engineering

Earthquake-induced vibration of single- and multi-degree-of-freedom systems; application to frames and to shear and torsional buildings; response spectrum analysis; building codes; static and dynamic lateral force procedures; seismic resistance of steel and concrete building frames.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): ESM 4404

ESM 5504:

Introduction to Ideal Flow

Kelvin-Helmholtz theory of vorticity. Velocity potential. Stream function. Complex potential and conformal mapping. Introduction to two-dimensional panel methods. Thin-airfoil theory. Steady and unsteady lifting flows. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5514:

Viscous Flow

Governing equations of viscous heat-conducting gases. Exact solutions to the Navier-Stokes equations. Low- Reynolds-number flows. Incompressible and compressible boundary layers. Finite-difference methods for boundary layers. Flow separation and strong viscous-inviscid interactions: interacting boundary layers and triple deck theory. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5014

Corequisite(s):

ESM 5524:

Compressible Flow I

Introduction to fundamentals of compressible fluid flow. Linearized theory, unsteady flows, steady flows, shock waves, wave interactions, method of characteristics. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5014

Corequisite(s):

ESM 5554:

Turbulence and Turbulent Flows

Nature and origin of turbulence, turbulent transport of momentum and heat, the dynamics of turbulence, statistical description of turbulence and spectral analysis. Examples of turbulent flows, boundary layers. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5574G:

Biomaterials

Biomaterials for medical 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. Materials for orthopedic, cardiovascular, and drug delivery applications. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5654:

Adhesion Science

371 Introduction to basic principles of adhesion science from the areas of

mechanics, materials, and chemistry. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5725:

Mathematical Methods in Engineering I,ii

Linear algebra and matrix theory, vector calculus, complex variables and integral transforms, ordinary and partial differential equations, special functions, integral equations and calculus of variations. Facility with an existing math software package of senior level engineering mathematics required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5726:

Mathematical Methods in Engineering I,ii

Linear algebra and matrix theory, vector calculus, complex variables and integral transforms, ordinary and partial differential equations, special functions, integral equations and calculus of variations. Facility with an existing math software package of senior level engineering mathematics required. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5734:

Introduction to the Finite Element Method

Formulation and computer implementation of finite element models of typical equations of fluid flow, heat transfer, and solid mechanics. The problems considered include heat conduction and convection, torsion, ground water flow, electrostatics and magnetism, plane elasticity, flow of viscous incompressible fluids, and plate bending. Both theoretical development and computer program development are studied. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5744:

Energy and Variational Methods in Applied Mechanics

Variational calculus, energy principles of solid mechanics, and variational methods of approximation applied to engineering problems. Derivation of equations of mechanics from energy and variational principles (i.e. virtual work principles). Formulation and solution of initial-, boundary- and eigen-value problems of engineering by direct variational methods, such as the Ritz, Galerkin, least-squares, and collocation methods. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4425

Corequisite(s):

ESM 5754:

Introduction to Perturbation Methods

Asymptotic expansions and series, approximate solutions of algebraic equations, straightforward expansions and their regions of nonuniformities, the Lindstedt-Poincare technique, the method of renormalization, the method of averaging, the method of matched asymptotic expansions. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 2214 OR MATH 2514 OR MATH 4544

Corequisite(s):

ESM 5764:

Modeling MEMS and NEMS

Modeling MEMS and NEMS is about the construction, analysis, and interpretation of mathematical and computational models of microelectromechanical and nanoelectromechanical systems (MEMS and NEMS). A goal throughout the course will be to develop a physical intuition for the fundamental phenomena at these small scales. The material covered will be broad and multidisciplinary including: dimensional analysis and scaling; a review of continuum mechanics; fluid dynamics, elasticity, thermal transport, and electromagnetism at the micro and nanoscales; the modeling of a variety of new MEMS/NEMS devices; and approaches beyond the continuum theory including stochastic and deterministic methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ESM 5944:

Seminar

Discussion of current research topics in Mechanics by local and visiting scholars. This course cannot be used to fulfill the minimum requirements of 30 hours toward the Master's Degree or 90 hours toward the Ph.D. Degree in Mechanics.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ESM 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ESM 6014:

Nonlinear Elasticity

Formulation and study of the equations of nonlinear elastic solids with application to bars, beams, plane elasticity, and plates. Updated and total Lagrangian incremental formulations using virtual work principles. Constitutive equations for compressible and incompressible solids. Analytical solution of some nonlinear problems. Nonuniqueness of solutions. Solution of the nonlinear equations by the Ritz, Galerkin and numerical methods. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5014, ESM 5744

Corequisite(s):

ESM 6044:

Theory of Plates and Shells

Reduction of 3-D elasticity to an equivalent 2-D counterpart. Basic assumptions. Field equations of the theory of plates and shells. Linear and nonlinear theories. Buckling and vibrations. Postbuckling. Refined plate and shell theories. Implications of non-classical effects on the static, dynamic and buckling behaviors. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Corequisite(s):

ESM 6054:

Fracture Mechanics

Linear elastic and elasto-plastic models of local stress fields around crack tips. Concepts of stress intensity strain energy release rate, strain energy density. Mathematical models for dynamic crack extension and fatigue crack growth. Correlation of mathematical models with fracture toughness testing. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5014

Corequisite(s):

ESM 6104:

Mechanics of Composite Strength and Life

Study of the mechanics associated with the description and prediction of the strength and life of composite materials and structures. Mechanistic, phenomenological, and analytical examination of strength and stability concepts for various reinforcement configurations. Effect of damage accumulation; micro-mechanics, damage mechanics, life prediction concepts and methods. Experimental investigative methods. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 6154:

Analysis of Composite Materials

3-D anisotropic constitutive theory, anisotropic elasticity, interlaminar stresses and edge effects, hygro-thermal stress analysis, failure, composite micro-mechanics, effective properties, heat conduction and moisture diffusion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4044, ESM 5074, ESM 5124

Corequisite(s):

ESM 6304:

Advanced Vibrations

Hamilton's principle and Lagrange's equations. Vibration of discrete

systems; the algebraic eigenvalue problem. Vibration of distributed systems; the differential eigenvalue problem; approximate methods; the finite element method. Substructure synthesis. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5304 OR MATH 4425

Corequisite(s):

ESM 6314:

Advanced Dynamics

Fundamental concepts of analytical mechanics, variational principles, Lagrange's equations, rigid-body kinematics and dynamics, Euler parameters, quasi-coordinates, Euler's equations, gyroscopic systems, Hamilton-Jacobi equation, transformation theory, introduction to optimal control theory, advanced concepts in stability theory. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5314

Corequisite(s):

ESM 6514:

Computational Methods for Viscous Flows

Navier-Stokes equations in curvilinear systems. Thin-layer and parabolized Navier-Stokes equations. Stability analysis of finite-difference methods applied to model equations. Methods for grid generation. Finite-difference methods for compressible and incompressible Navier-Stokes equations. Spectral methods. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 5514

Corequisite(s):

ESM 6714:

Applied Tensor Analysis

Basis vectors, Christoffel symbols, metric tensor. Covariant, contravariant vectors and tensors. Covariant differentiation. Orthonormal systems and physical components of tensors. Surface tensors, curvature tensors, principal curvatures, geodesics and asymptotic lines. The basic ideas will be illustrated by and applied to problems in continuum mechanics, solid and fluid mechanics, rigid body dynamics, and

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 4574

Corequisite(s):

ESM 6734:

Finite Element Analysis

Alternative finite element models; three-dimensional problems; eigenvalue problems; nonlinear formulations for fluid flow and plate bending; and mathematical properties of finite-element approximations; direct and Newton-Raphson iterative methods for the solution of nonlinear equations; computer implementation of nonlinear finite-element models. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4734 OR ESM 5734

Corequisite(s):

ESM 6974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ESM 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ESM 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENVIRONMENTAL ENGINEERING

William Easterling, Head

Emeriti Faculty: William Cox; Thomas Grizzard; John Novak; Clifford Randall;

Professors: Gregory Boardman; Andrea Dietrich; Marc Edwards; William Knocke; John Little; Linsey Marr; Glenn Moglen; Amy Pruden-Bagchi; Peter Vikesland; Mark Widdowson;

Associate Professors: Randel Dymond; Daniel Gallagher; Zhen He; Jennifer Irish; Kyle Strom;

Assistant Professors: Erich Hester; Nina Stark;

Research Associate Professors: Adil Godrej;

Charles P. Lunsford Professor: Marc Edwards;

W. Curtis English Professor: William Knocke;

Research Assistant Professors: Husen Zhang;

Charles E. Via, Jr. Professor: John Little;

Assistant Professor of Practice: Robert Scardina;

Graduate Contact: leigha@vt.edu

National Capital Region: jeny15@vt.edu

Extended Campus: blucas06@vt.edu

Student Handbook:

http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

Graduate Site: <http://www.cee.vt.edu/>

National Capital Region: <http://www.ncr.vt.edu/programs/CEE.html>

The Environmental Engineering (ENE) Program of the Department of Civil and Environmental Engineering offers graduate study leading to the MS in environmental and water resources engineering and the PhD in civil engineering (with an environmental and water resources engineering emphasis). The program goals are to educate and prepare engineers for careers in the various fields of environmental engineering design, water supply management, site remediation, environmental modeling, pollution control engineering, water resources engineering, and public health protection. The MS in environmental engineering is open to students from all undergraduate engineering curricula or in a related field of science such as Biology, Chemistry, Mathematics, Soil Science, Statistics or Geology. It is specifically designed to build upon undergraduate degrees in civil, biological systems, chemical, mechanical, and mining engineering. Within a few years of program completion, graduates of the ENE program should be able to combine skills gained through academic preparation and post-graduation experience so that they can: Exhibit technical competence through application of engineering knowledge problem-solving skills, and modern tools from multiple areas of environmental engineering practice in the analysis, evaluation, design, and construction of environmental engineering systems and system components. Apply skills of effective communication, teamwork, leadership, and professional and ethical behavior as complements to technical competence. Incorporate economic, environmental, social, and sustainability considerations into

the practice of environmental engineering. Continue their technical and professional development, which may include professional licensure, graduate level education, continuing education courses, self-directed study, and participation in conference and committee activities. Please refer to the Civil and Environmental Engineering listing for more detailed information on the CEE Department, the academic "home" of the ENE program. (<http://www.cee.vt.edu/>). National Capital Region web site: <http://www.ncr.vt.edu/programs/CEE.html>

SPECIAL FACILITIES

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Computing Facilities

The Civil and Environmental Engineering Computer Lab (CEECL) is maintained as a state-of-the-art, collaborative learning environment. The instructional lab provides excellent multimedia equipment for faculty to demonstrate and instruct students in the use of computing tools through the Department's curriculum. Faculty and students also have access to a variety of supercomputing facilities and data visualization capabilities through the computer resources of Virginia Tech.

Experimental Facilities

The environmental engineering program occupies modern laboratories in Durham, ICTAS I & II, Patton and Hancock Halls. Laboratories and specialized experimental and analytical equipment support research programs related to areas such as water and wastewater treatment, hazardous and residuals waste management, water quality management, environmental chemistry, and air quality. Available equipment allows for the identification and quantification of most chemical and microbial environmental contaminants. The water resources engineering laboratories support basic and applied research activities in the areas of water, sediment, and pollutant movement in surface and groundwater sources. The Kelso Baker Environmental Hydraulics Laboratory houses two large (each 70 ft. long) tilting flumes, a medium length tilting flume, a 3-D laser Doppler velocimeter, a hot film anemometer, and numerous pieces of support instrumentation.

Occoquan Watershed Monitoring Laboratory (Manassas, Virginia)

The environmental engineering program also includes the Occoquan Monitoring Laboratory (Manassas, Virginia), where research focuses on wastewater reuse, reservoir eutrophication control, and watershed monitoring and management. Web site: www.owml.vt.edu

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal, Quantitative, Analytical

The purpose of the core curricula is to develop an understanding of the applicable chemical, physical, biological, and mathematical modeling fundamentals and then teach student how to apply these principles in a broad range of applied courses. Specialization can be in the traditional areas of air quality engineering, environmental modeling and simulation, environmental nanotechnology, hazardous waste management, water infrastructure, water resources engineering and water and wastewater process engineering. Emerging thrust areas include sustainable water supply and water reuse, water infrastructure and environmental nanotechnology. The MS ENE degree may be taken either as coursework only or with the permission of the faculty may incorporate a research thesis. The PhD program In Civil Engineering is designed to build upon the MS in environmental engineering, but also is open to students with master's degrees in other engineering disciplines. Areas of specialization are the same as for the MS degree, but the program of study are more individualized. See Departmental Manual at http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

GRADUATE COURSES (CEE)

CEE 5010:

Schedule Impact Analysis

Analysis of construction scheduling principles, scheduling specifications, contract administration, construction law, construction delay claims, and of accepted methodologies for performing schedule impact analysis of delaying events.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4024 (UG) OR CEE 4024

Corequisite(s):

CEE 5014:

Facility Delivery & Financing

Delivery and financing of constructed facilities with an emphasis upon civil infrastructure systems. Design of project delivery systems to encourage best value, innovation, and private sector participation. Public-private partnership strategies and factors that contribute to success or failure. Fundamentals of project feasibility, evaluation, and finance. Case studies of large-scale infrastructure projects. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5024:

Contract Administration and Claims Resolution

This course provides students with a knowledge of the different types of contracts used in civil engineering construction. Contracts are viewed as documents which assign responsibilities and allocate risks and emphasis is placed on contract administration as the first step in reducing costs and easing the burden of dispute resolution. Techniques for quantifying and resolving claims are studied. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5034:

Construction Systems Design and Integration

This course will study building systems, their design and how to best manage the life cycle cost of the systems. The course will have particular emphasis on systems. The course will have particular emphasis on mechanical and electrical equipment in buildings, solar design, lighting design, site orientation, value engineering and constructability of the various systems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5040:

Design of Construction Operations

Design and analysis of construction operations using discrete-event simulation modeling. Modeling construction operations using activity cycle diagrams. Collection and reduction of construction data. Selection of distribution models and estimation of parameters. Goodness of fit testing. Assessment of independence and autocorrelation. Design of simulation experiments. Output analysis and confidence intervals of performance measures. Variance reduction techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5044:

Construction Research Presentation

This course requires that students produce a written paper and make an oral presentation based on a construction research topic of their choice.

It is designed to sharpen skills in the written and oral presentation of technical material. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): CEE 6014

CEE 5050:

Construction Decisions Under Uncertainty

Construction project and organization decisions for the uncertain future. Selection of construction methods, equipment, project and operation attack strategies, contract, markup, and financing alternatives having the highest expected values and utilities. Use of decision and utility theory, competitive bid analysis, and probabilistic modeling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5054:

Construction Performance Improvement

Skills for productivity improvement in construction, with special attention to techniques used to record and analyze operations as required to develop and implement efficient and rewarding methods. Consideration of the human factor in generating and implementing commitments to productivity improvements. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3014 (UG) OR CEE 3014

Corequisite(s):

CEE 5064G:

Design Hazard Control Construct

Design of construction projects and systems to control inherent hazards to the health and safety of construction workers, inhabitants of the built environment, and the general public. Regulatory and legal factors

pertinent to construction, chemical and physical health hazards, major classes of safety hazards, design processes, and specifications to control safety and health hazards, system engineering risk analysis tools, and safety management processes. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5070:

Equipment Economics and Applications

Methodologies for determining the owning and operating cost and economic life of construction equipment. Application of engineering economics to equipment management decisions with particular reference to maintain, rebuild, replace decisions. Techniques to analyze equipment intensive operations, determine actual and delay free cycle times, match individual units and balance fleets. Synthesis of knowledge regarding production and cost to optimize productivity and reduce unit costs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5074:

Global Virtual Design and Construction

Fundamental aspects of modern civil engineering project execution in virtual workspaces. Participation in team-based virtual design and construction project involving students from other domestic and international universities. Design of organizational and task model, integration with design and cost models, identification of interventions that improve scheduling. Strengthened ability to work collaboratively with individuals from different countries/cultures. Both theory and practice emphasized. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5080:

Infrastructure Asset Mgt

Comprehensive systems approach to civil infrastructure system and strategic-level asset management with emphasis on municipal, highway, building, dam, and bridge infrastructure. Course will cover various aspects of strategic-level infrastructure asset management: systems thinking, needs assessment, information technology and GIS data management, risk and reliability engineering, multi-criteria decision making process, infrastructure sustainability and resiliency, and renewal engineering (repair, rehabilitation, and replacement). Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5084:

Information Technology for Infrastructure and Environment Systems

With the acceleration of the process of global revolution in science, engineering and technology led by information technology, the human society is in a gradual transition from an industrial society into an information society. As a new productivity with the greatest potential at the present age, information technology has undergone great development. The incessant innovation in technology has also urged people to make better use of it and apply advanced information technology to their own industry. In recent years, Information Technology (IT) and Cyber Infrastructure has been transforming engineering and business practices in many sectors, resulting in efficiency gains and improved services for the client. The infrastructure industry has been slow to utilize information technology effectively and slower still to grasp the ways in which the multitude of design, calculation, specification, project management, asset management, sensor technology, database and data analysis software applications relate to each other. This course provides an overview of the range of Information Technology (IT) applications available to the civil and environmental professional throughout the life cycle of a project, from data collection and analysis through software, project management, environmental impact analysis, visualization, and infrastructure asset management. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5094:**CII Best Practices**

Introduction to Construction Industry Institute (CII) Best Practices, including Front End Planning Zero Accident Techniques, Constructability, and Material Management that affects construction projects. Management influences on construction processes and critical issues. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5104:**Environmental Chemistry**

Applied, environmental aspects of physical, organic, and inorganic chemistry; including applications in sanitary engineering of the phenomena of precipitation, complexation, buffering capacity, and chemical equilibria. Review of the nomenclature and properties of organic compounds.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5124:**Fundamentals of Environmental Toxicology**

Introduction to nomenclature, principles, and scope of environmental toxicology. The fate and effects of both organic and inorganic toxicants in the environment, in animals, and in various test systems. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5104 (UG) OR CEE 5104

Corequisite(s):

CEE 5125:**Environmental Engineering Design**

5125: Design of wastewater treatment facilities for the reduction and elimination of organic and inorganic pollutants; 5126: Design of water treatment facilities for the production of potable waters from surface and groundwater systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s):

CEE 5126:**Environmental Engineering Design**

5125: Design of wastewater treatment facilities for the reduction and elimination of organic and inorganic pollutants; 5126: Design of water treatment facilities for the production of potable waters from surface and groundwater systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5130G:**Adv Indoor Enviro Qual Sustain**

Indoor environmental quality factors and associated sustainable design methods and approaches. Air contaminant sources, emission and dispersion patterns, health impacts, and control solutions. Methods of improving IEQ through material and ventilation solutions. Applicable regulatory requirements and sustainability organization recommendations will be reviewed. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5134:**Engineering Aspects of Water Quality**

The application of biological, chemical, and physical principles of water quality to engineering problems in surface waters.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s):

CEE 5144:**Unit Operations and Processes Laboratory**

Applied science aspects of water and waste treatment; advanced research techniques in analysis and treatment of water and wastes.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (CEE 5125 (UG) OR CEE 5126 (UG)) OR (CEE 5125 OR CEE 5126)

Corequisite(s):

CEE 5154:**Air Pollution Transport and Chemistry**

Principles and practice of air pollution source control with emphasis on stationary source control and equipment operating and design parameters; economic and technical evaluation of control system design alternatives.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5174:**Industrial and Hazardous Wastes Control**

Contemporary methods for the management and treatment of industrial wastewaters, including in-plant reductions and reuse. Characterization and management of hazardous wastes. Design of appropriate systems.

II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5134 (UG) OR CEE 5134

Corequisite(s):

CEE 5184:**Techniques for Environmental Analysis**

An introductory course on techniques commonly utilized for analysis of environmental samples. Course will discuss gas and liquid chromatography, mass spectrometry, and atomic absorption spectroscopy, focusing on analysis of complex environmental samples.

Practical techniques and applications are emphasized, but sufficient theory is introduced to provide students with an understanding of the principles involved.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5194:**Environmental Engineering Microbiology**

Roles of microorganisms in wastewater treatment, anaerobic digestion of municipal sludges, stream self-purification, and degradation of water quality in drinking-water systems. Disinfection of wastewater and drinking water to remove viruses, bacteria, and protozoa that cause waterborne disease.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

CEE 5204:**Gis Applications in Civil Engineering**

Examination of data structures used in geographic information systems. Map projections and coordinate systems used in mapping. Database creation, maintenance, and integrity. Applications of GIS methods for solving civil engineering problems in land management and related areas. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5224:**Advanced GIS Applications in Civil and Environmental Engineering**

This project based course deals with both vector and raster Geographic Information Systems (GIS), network analysis, tracking applications, hydrologic applications, spatial analysis, web databases, and linking GIS to models with programming, specifically in the civil and environmental engineering arena. Pre: Any introductory GIS course, including CEE 5204, GEOG 4084, or BSE 4344. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

380 Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5244 (BSE 5244):

Advanced GIS in Hydrologic Analysis

Advanced GIS course focusing on raster analysis with particular application to the issues associated with hydrologic analysis. Application and evaluation of algorithms for terrain analysis, watershed characterization, and hydrologic analysis and modeling as implemented in GIS. Digital elevation data sources and error assessment. Approaches to GIS/model integration and application.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (BSE 4344 (UG) OR CEE 5204 (UG) OR GEOG 4084 (UG), BSE 3305 (UG) OR CEE 4304 (UG)) OR (BSE 4344 OR CEE 5204 OR GEOG 4084, BSE 3305 OR CEE 4304)

Corequisite(s):

CEE 5264G:

Advanced 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5304:

Environmental Fluid Mechanics

The first part of the course will be devoted to basic concepts and equations of fluid motion. The remainder of the course will be concerned with the theory of incompressible viscous and inviscid fluids. Selected applications will be drawn from environmental and water resources topics. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3314 (UG) OR CEE 3314

Corequisite(s):

CEE 5314:

River Mechanics and Sediment Transport

Sediment properties; critical stress; bed-form regimes in alluvial streams; depth-discharge relations for rivers; bed load and suspended load movement; river stability; flow in bends; river training.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4324 (UG) OR CEE 4324

Corequisite(s):

CEE 5324:

Advanced Hydrology

Applications of statistics to hydrology, floods, and droughts; flow generation models; mathematical models in physical hydrology; difference methods in flow routing; kinematic wave; evapo-transpiration; infiltration; and atmospheric processes. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4304 (UG) OR CEE 4304

Corequisite(s):

CEE 5344:

Surface Water-Groundwater Interaction

Interaction (exchange) of surface water with groundwater at watershed, reach, sediment-patch scales including bidirectional hyporheic flows. Focus on streams and rivers, consideration of lakes. Steady and unsteady exchange hydraulics including laminar and turbulent flows. Exchange benefits and engineering goals including heat transfer, nutrient processing, and contaminant attenuation. Engineering applications including conjunctive use of surface water and groundwater resources and impact of groundwater pumping on rivers. Field methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5354 (GEOS 5814):

Numerical Modeling of Groundwater

Theory and practice of numerical techniques are developed and applied to fluid flow and transport in ground-water flow systems. Governing equations are formulated using FD and FE techniques with appropriate BC's and IC's. Additional topics include: model conceptualization and

grid design in multidimensional systems; practical applications of numerical models including calibration, validation, and prediction; concepts and techniques of advective transport using particle tracking and dispersive transport. Introduction to MODFLOW, MODPATH, MT3D, and others. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (GEOL 4114 (UG) OR CEE 4314 (UG)) OR (GEOL 4114 OR CEE 4314)

Corequisite(s):

CEE 5364:

Water Law

Analysis of law for allocation of surface and groundwater supplies, legal controls over water quality alteration, public rights of water use, and drainage law. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4804 (UG) OR CEE 4804

Corequisite(s):

CEE 5374:

Dynamics Groundwater

The theory of dynamics of fluids in porous media; fluid and matrix properties; transport equations; boundary and initial value problems; flow of immiscible fluids; dispersion. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4314 (UG) OR CEE 4314

Corequisite(s):

CEE 5384:

Transport Processes in Waterways

Advanced treatment of the mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow. Independent research project. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5404:

Plate and Shell Structures

Classical solutions of elastic plate theory; approximate methods; continuous plates; orthotropic plates. Theory of thin shells of revolution; membrane and bending actions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3404 (UG) OR CEE 3404

Corequisite(s):

CEE 5414:

Finite Element Analysis of Structures

Formulation of the finite element method and application to skeletal, plate, and shell structures. Study of mesh layout and refinement, convergence characteristics, and solution accuracy. Tests of element quality. Use of commercial finite element codes such as ABAQUS.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5424:

Computer Analysis of Structures II

Extension of matrix displacement method to skeletal space structures: space trusses, space frames, and grids. Incorporation of special features such as nonglobal constraints, assemblies of different types of elements, thermal problems, substructuring, and buckling analysis. Development of well-structured programs on the mainframe and transfer to the personal computer.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4404 (UG) OR CEE 4404

Corequisite(s):

CEE 5424G:

Intermediate Design of Prestressed Concrete Structures

Principle of prestressing applied to concrete beams, slabs, and frames; design of individual elements and structural systems of prestressed

382 concrete; precast construction and connection design. Graduate

Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3424 (UG) OR CEE 3424

Corequisite(s):

CEE 5430:

Intermediate Design of Steel Buildings

Design of major components in steel-framed buildings, including composite beams and slabs, beam-columns, and moment connections.

Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5434:

Design of Cold-formed Steel Structures

Behavior and design of cold-formed steel members. Strength of thin plate elements; flexural members; compression members, symmetric and non-symmetric; beam-columns; welded, bolted, and screw-fastened connections. Building systems that utilize cold-formed steel members. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3434 (UG) OR CEE 3434

Corequisite(s):

CEE 5444:

Stability of Structures

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 structural design criterion. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5454:

Elastic Stability

Stability of elastic structural components under conservative loads; precise definitions of stability; energy approaches; Rayleigh-Ritz and Galerkin methods; and applications to column, arches, plates, and shells. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3404 (UG) OR AOE 3124 (UG)) OR (CEE 3404 OR AOE 3124)

Corequisite(s):

CEE 5464:

Structural Dynamics and Earthquake Engineering

Earthquake-induced vibration of single- and multi-degree-of-freedom systems; application to frames and to shear and torsional buildings; response spectrum analysis; building codes; static and dynamic lateral force procedures; seismic resistance of steel and concrete building frames.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3424 (UG), CEE 3434 (UG)) OR (CEE 3424, CEE 3434)

Corequisite(s): CEE 4404

CEE 5470:

Structural Design for Seismic Load Effects

Analysis and design of steel and reinforced concrete structures for seismic load effects. Fundamental principles of earthquake engineering, as rooted in seismic hazard analysis, inelastic behavior, and dynamic response. Application of these principles to the design and detailing of reinforced concrete and structural steel buildings. Building code requirements for seismic loading and seismic resistant design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3434 (UG), CEE 4404 (UG), CEE 5464 (UG)) OR (CEE 3434, CEE 4404, CEE 5464)

Corequisite(s):

CEE 5474:

Advanced Reinforced Concrete Design

other advanced topics related to design of reinforced concrete structures.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3424 (UG) OR CEE 3424

Corequisite(s):

CEE 5474G:

Intermediate Reinforced Concrete Structures

Behavior and design of continuous reinforced concrete structures subjected to gravity and lateral loads. Application of computer programs to frame analysis and design of members. Development length, biaxial bending of columns, continuous one-way beams and slabs, two-way floor systems, torsion, footing, and cantilever retaining wall design problems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3424 (UG)

Corequisite(s):

CEE 5484:

Concrete Bridge Design

Relationship of bridges to national needs; illustration of a preliminary design by case history; design of conventional bridge decks and girders; curved box-girder bridges; segmental construction; cable-stayed bridges; importance of design details on the seismic resistance of bridges.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3424 (UG), CEE 3434 (UG)) OR (CEE 3424, CEE 3434)

Corequisite(s):

CEE 5494:

Reliability Methods in Structures and Mechanics

Theory of structural reliability; reliability based designs, safety index, linear and nonlinear design equations, load and resistance factors, Level I, II and III formats, code formulations; systems reliability, bounds on reliability.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 4614 (UG) OR STAT 4706 (UG)) OR (CEE 4614 OR STAT 4706)

Corequisite(s):

CEE 5494G:

Intermediate Computer Methods on Structural Design

Design of structural members in steel, concrete, and wood using computers. Computer-aided design of structural systems. Development of computer programs for the solution of structural design projects.

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5504:

Risk Analysis Geotechnical Engineering

Methods for risk analysis of complex systems. Basic concepts of probability and reliability applied to geotechnical engineering problems. Geostatistics concepts. Probabilistic seismic hazard analysis and performance based design. Computational tools and simulation methods. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5514:

Soil Behavior

Behavior of soil examined from a fundamental soil perspective. Review of methods of testing to define response; rationale for choosing shear strength and deformation parameters for soils for design applications. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3514 (UG) OR CEE 3514

Corequisite(s):

CEE 5524:

Advanced Soil Testing for Engineering Purposes

384 Methods of testing and analysis of soil for engineering properties

including compressibility; strength in triaxial, simple, and direct shear; permeability; and stability.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CEE 4524 (UG) OR CEE 4524

Corequisite(s):

CEE 5534:

Foundation Engineering I

Behavior and design of retaining walls and shallow foundations. Earth pressures, bearing capacity, and settlement. Stress distribution and consolidation theories. Settlement of shallow foundations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3514 (UG) OR CEE 3514

Corequisite(s):

CEE 5544:

Foundation Engineering II

Behavior and design of anchored bulkheads, excavation bracing, driven piles, drilled piers and buried structures. Effects of pile driving. Response of deep foundations to vertical and horizontal loads. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5534 (UG) OR CEE 5534

Corequisite(s):

CEE 5554:

Soil and Site Improvement

Methods of soil and site improvement including design techniques for dewatering systems, grouting, reinforced earth, in-situ densification, stone columns, slurry trenches, and the use of geotextiles. Construction techniques for each system are described. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3514 (UG) OR CEE 3514

Corequisite(s):

CEE 5564:

Seepage and Earth Structures

Soil permeability and seepage through soils. Embankment design. Compaction, earth pressures and pressures in embankments. Slope stability analysis. Settlements and horizontal movements in embankments. Landslide stabilization. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5514 (UG) OR CEE 5514

Corequisite(s):

CEE 5574:

Environmental Geotechnics

Geotechnical aspects of environmental engineering projects. Fundamentals of soil behavior, site characterization, and contaminant transport; methods for geotechnical engineering practice for waste disposal, waste containment, and site remediation; waste landfills. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3104 (UG), CEE 3514 (UG)) OR (CEE 3104, CEE 3514)

Corequisite(s):

CEE 5584:

Geotechnical Aspects of Earthquake Engineering

Causative mechanisms of earthquake, earthquake magnitudes, ground motion, effect of local soil conditions on motions. Response of soils to seismic loading, liquefaction phenomena and analysis of pore pressure development, laboratory and in-situ testing for seismic loading. Analysis and design of slopes, embankments, foundations, and earth retaining structures for seismic loading. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4544 (UG) OR CEE 4544

Corequisite(s):

CEE 5594 (GEOS 5594):

Geological Engineering

Mechanical and hydraulic properties of rock masses; analysis and design of rock foundations, slopes, tunnels, and other forms of civil infrastructure; rock reinforcement. Pre: Graduate Standing.

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5600:

Civil Infrastructure Systems Analysis

Systems analysis, modeling infrastructure systems by mathematical programming, measuring infrastructure systems performances, probabilistic analysis of infrastructure systems, multiple attribute decision making in infrastructure systems. Pre: Graduate standing in engineering is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5604:

Traffic Characteristics and Flow

Driver, vehicle, and roadway characteristics; stochastic modeling of traffic processes including queueing theory, headway distributions, and gap acceptance; stream flow characteristics including car-following and multilane traffic models, roadway capacity and bottleneck analysis, network operations, and fuel consumption models. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CEE 4604 (UG) OR CEE 4604

Corequisite(s):

CEE 5614:

Analysis of Air Transportation Systems

Planning, design and operation of aviation systems with computer aided design tools and computer simulation models. Airline airport operations and practices and their effect in airport planning and design. Air cargo facilities planning and modeling. State-of-the-art computer simulation models used in aviation environmental planning and airspace modeling. Graduate standing in CE required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5620:

Transportation Network Analysis

Optimal paths in transportation networks, transportation network design, vehicle routing and scheduling, facility location problems, traffic flows on networks, traffic assignment problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5624:

Transportation and Land Use

Interaction between transportation and land use variables, including modeling requirements, impacts, and data needs within the context of good community planning and economic development; elements of transportation and land use that shape the quality of life in urban areas.

II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5630:

Design and Operation of Advanced Public Transportation Systems

An overview of the use of intelligent transportation systems (ITS), technologies and user services in design and operation of advanced public transit systems (APTS); emphasis is placed on communication, sensor application, information processing, traffic control, en-route and pre-trip information, electronic payment, and fleet management as they pertain to transit and paratransit services in large metropolitan areas as well as in small urban and rural communities.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5634:

Analysis and Planning of Mass Transit Systems

386 An overview of mass transit systems; transit system planning including

demand and cost analysis and evaluation; transit system design including route design, scheduling, and fare policy; transit networks and marketing; para transit systems; future trends in mass transit. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5640:

Highway Transportation Safety

Identification of highway safety problems and development of solutions. User characteristics and expectations, road audits, roadside hardware systems, safety enhancing treatments, standard traffic control devices, real-time information and control systems, work zone and railroad crossing treatments, older driver design concepts, traffic calming, designs for pedestrians and bikes, delineation and lighting principles, and advanced 3D/4D design concepts. Group and individual analyses of problems. Pre: Graduate standing in engineering is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5644:

Transportation Systems Planning

Advanced consideration of problems dealing with transportation systems as they affect the socio-economic development of cities, regions, and nations; the travel behavior of a populace; the location of economic activity; the use of land; and the allocation of resources. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604 (UG) OR CEE 3604

Corequisite(s):

CEE 5654:

Critical Issues in Transportation

Technological, societal, economic, political, environmental, health, and energy effects on planning, design, operation, and management of the transportation system. Modeling of complex interactions and causal relationships among current issues. Principles of optimization for design and operation of the five basic elements of transportation (vehicles,

networks, terminals, controls, and system administration). Problem definition, objectives identification, model development, alternatives generation and evaluation, and reasoning process for transportation investment. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

CEE 5660:

Trans Risk, Reliab & Security

Transportation risk assessment and computation; evacuation modeling; reliability analysis; infrastructure interdependency analysis; network impact assessment. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MATH 2224 (UG), (STAT 3704 (UG) OR STAT 4604

(UG) OR STAT 4705 (UG))

Corequisite(s):

CEE 5670:

Applied Traffic Engr Analysis

Definition of traffic engineering and theory of traffic engineering. Evaluation and identification of traffic engineering problems and development of solutions. Application of theory to real-world problems using intersection design and control, analysis of capacity and level of service for freeways and arterials, traffic signal design and optimization, geometric design, highway and intersection simulation. Pre-requisite: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5674:

Advanced Pavement Design

Methods used to characterize, stabilize, and specify pavement materials. Methods for rigid and flexible highway and airport pavement design and analysis. Load equivalence factor and specific design considerations related to environment and traffic characteristics. Pavement overlay design. Software for pavement design and analysis using various

models. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3684 (UG), CEE 4664 (UG)) OR (CEE 3684, CEE 4664)

Corequisite(s):

CEE 5684:

Rehabilitation of Transportation Structures

Identification of maintenance and rehabilitation needs for transportation structures such as bridges and pavements. Cost effective maintenance and rehabilitation methods. Consideration of bridge and pavement management systems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5694:

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 5704:

Environmental Chemistry Laboratory

Laboratory course in support of 5104, Environmental Chemistry, allowing students to perform experiments related to natural environmental processes, including biological oxygen consumption, complexation, and carbonate equilibria. Consideration of laboratory procedures used to investigate and assess environmentally related materials and their contaminants.

Credit Hour(s): 1

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s):

Corequisite(s): CEE 5104

CEE 5714:

Surface Water Quality Modeling

Use, analysis, and development of water quality models for lakes, rivers, and estuaries. Emphasis on model calibration, verification, and post-audit analysis. Lab portion will develop and apply a eutrophication model for an estuary using existing data.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

CEE 5724:

Environmental Monitoring and Sampling

Experimental design and sampling techniques for environmental analysis, including environmental monitoring techniques and statistical principles for planning monitoring locations and frequencies at environmental sites such as landfills, rivers, lakes, and the atmosphere. Development of monitoring strategy; examination of sampling techniques for various sample types. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 2004 (UG) OR STAT 2004

Corequisite(s): CEE 5104

CEE 5734:

Urban Hydrology and Stormwater Management

Development of methods and numerical models for computing surface runoff from developing watersheds; hydraulics of combined sewer systems; urban non-point source pollutant load calculations and best-management practices; control strategies for regional stormwater management; detention basin design for control of urban floods and non-point source pollutants. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4304 (UG) OR CEE 4304

Corequisite(s):

CEE 5744:**Topics in Structural Steel Design**

Calculation of stresses in steel members. Overall-local buckling interaction. Design of singly symmetrical and unsymmetrical columns and topics on flexural design, design of plate girders, bracing design, and design of framing connections. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3434 (UG) OR CEE 3434

Corequisite(s):

CEE 5754:**Pavement and Bridge Infrastructure Management Systems**

Management concepts used in civil infrastructure; planning, design, construction, maintenance, and rehabilitation of bridge and highway systems. Prioritization, optimization, and decision-making techniques. Life-cycle-cost prediction.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 3684 (UG), CEE 4664 (UG)) OR (CEE 3684, CEE 4664)

Corequisite(s):

CEE 5764:**Asphalt Technology**

Origin, types and properties of bituminous materials and their use in civil engineering. Asphalt rheology. Theory behind technological processes and procedures for hot-mix asphalt including design philosophy, performance, and durability. Modern construction with bituminous materials; special mixtures, recycling, and additives. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CEE 4614 (UG) OR CEE 4614

Corequisite(s):

CEE 5774:**Hazardous Waste Management**

Review of regulatory framework governing hazardous waste management. Characteristics of hazardous wastes. Fundamental physical, chemical, and biological principles applied to the design of treatment processes. Risk management. Case studies. Design project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s): CEE 5104

CEE 5794:**Environmental Engineering Principles**

Examines the basic physical, chemical, and microbiological principles that provide the foundation for environmental engineering. Illustrates how these principles are applied to solve a wide range of environmental problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CEE 3104 (UG) OR CEE 3104

Corequisite(s): CEE 5104

CEE 5804:**Engineering Ethics and the Public**

Moral obligations of engineers and scientists toward the publics they serve; responsible conduct of research; responsible conduct of practice; the responsibilities and risks of witnessing wrongdoing; the value of non-expert knowledge claims and the importance of listening to public stakeholders. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5894:**Final Examination**

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5904:**Project and Report**

Credit Hour(s): 1 TO 19

389 Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CEE 5944:

Seminar

Review and discussion of current literature, research, and consulting activities by student, faculty, and guest speakers. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

CEE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CEE 6014:

Project and Company Management

Study of the management of a construction project and a construction

company. Project management includes finances, cash flows, cost control, project organization, and project planning. Company management includes company organization incorporation structure, procedures, finance, insurances, accounting, and operation. Case studies are emphasized. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CEE 6104:

Advanced Environmental Chemistry

Advanced theories and practices in environmental engineering with special emphasis on inorganic aspects of water chemistry; application of water chemistry fundamentals for the description of aquatic systems. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 5104 (UG) OR CHEM 3616 (UG)) OR (CEE 5104 OR CHEM 3616)

Corequisite(s):

CEE 6114:

Advanced Topics in Air Quality Engineering

Review and critique of current research. Emissions, transport, transformation, and fate of gases and particles in the atmosphere. May be repeated with different topic content for a maximum of 3 credits.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5154

Corequisite(s):

CEE 6404:

Dynamics of Structures

Formulation of equations of motion by the finite element method. Solution by mode superposition and direct methods. Earthquake analysis and nonlinear analysis. Application to skeletal and plate structures. Development of computer programs and use of commercial programs.

Credit Hour(s): 3

Lecture Hour(s): 3

390 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CEE 5414 (UG), ESM 4074 (UG)) OR (CEE 5414, ESM 4074)

Corequisite(s):

CEE 6424:

Advanced Prestressed Concrete

Behavior and design of prestressed slabs, bridges, and precast building systems. Continuous prestressing; load-balancing method for slabs; torsion and shear; connections for precast members; partial prestressing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4424 (UG) OR CEE 4424

Corequisite(s):

CEE 6434:

Advanced Steel Design

Advanced topics of current interest in structural steel design research as given by recent publications and informal reports. In-depth study of selected projects. May be repeated. 12 credits of 5000-level courses in structures or solid mechanics required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 4434 (UG) OR CEE 4434

Corequisite(s):

CEE 6504:

Theoretical Soil Mechanics

Constitutive Laws for Soils, nonlinear elastic and plastic models. Consolidation, layered systems, sand drains, approximate three-dimensional theories, and Biot's poro-elastic formulation. Plastic equilibrium in soils Sokolovski's method of characteristics, applications to earth pressure, bearing capacity, and slope stability problems. Analysis of machine foundation problems, elastic waves through soils, dynamic properties of soils. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 5514 (UG) OR CEE 5514

Corequisite(s):

CEE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CEE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENVIRONMENTAL SCIENCES AND ENGINEERING

William Easterling, Head

Emeriti Faculty: William Cox; Thomas Grizzard; John Novak; Clifford Randall;

Professors: Gregory Boardman; Andrea Dietrich; Marc Edwards; William Knocke; John Little; Linsey Marr; Glenn Moglen; Amy Pruden-Bagchi; Peter Vikesland; Mark Widdowson;

Associate Professors: Randel Dymond; Daniel Gallagher; Zhen He; Jennifer Irish; Kyle Strom;

Assistant Professors: Erich Hester; Nina Stark;

Charles P. Lunsford Professor: Marc Edwards;

Research Associate Professors: Adil Godrej;

W. Curtis English Professor: William Knocke;

Charles E. Via Jr. Professor: John Little;

Nick Prillaman Professor: John Novak;

Research Assistant Professors: Husen Zhang;

Assistant Professor of Practice: Robert Scardina;

Graduate Contact: leigha@vt.edu

Extended Campuses: blucas06@vt.edu

National Capital Region: jeny15@vt.edu

Graduate Site: <http://www.cee.vt.edu>

Graduate Policy:

http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

National Capital Region: <http://www.ncr.vt.edu/programs/CEE.html>

The Environmental Science and Engineering (ESEN) program is designed to prepare undergraduates with a science background to work with engineers in various fields including, water supply, wastewater management, public health, watershed management, stream protection, groundwater remediation and air resource management. Appropriate disciplines include, but are not limited to biology, chemistry, geology, agronomy, soil science and environmental science. A wide range of courses can be taken to fulfill the degree requirements, depending on the background and interests of the student. The purpose of the core curricula is to develop an understanding of the applicable chemical, physical, biological, and mathematical modeling fundamentals and then teach students how to apply these principles, along with their previous scientific training, to the solution of environmental problems. Appropriate employment is with consulting firms, regulatory agencies, municipalities and industry. The program administratively is under the direction of the Head of the Department of Civil and Environmental Engineering (<http://www.cee.vt.edu/>) and the program direction is by a faculty committee from Departments in the College of Engineering, Agriculture and Science.

SPECIAL FACILITIES

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Computing Facilities

The Civil and Environmental Engineering Computer Lab (CEECL) is maintained as a state-of-the-art collaborative learning environment. The instructional lab provides excellent multimedia equipment for faculty to demonstrate and instruct students in the use of computing tools through the Department's curriculum. Faculty and students also have access to a variety of supercomputing facilities and data visualization capabilities through the computer resources of Virginia Tech.

Experimental Facilities

Experimental Facilities The Environmental Science and Engineering (ESEN) program occupies modern laboratories in Durham, ICTAS I & II, Patton and Hancock Halls. Laboratories and specialized experimental and analytical equipment support research programs related to areas such as water and wastewater treatment, hazardous and residuals waste management, water quality management, environmental chemistry, and air quality. Available equipment allows for the identification and quantification of most chemical and microbial environmental contaminants. The water resources engineering laboratories support basic and applied research activities in the areas of water, sediment, and pollutant movement in surface and groundwater sources. The Kelso Baker Environmental Hydraulics Laboratory houses two large (each 70 ft. long) tilting flumes, a medium length tilting flume, a 3-D laser Doppler velocimeter, a hot film anemometer, and numerous pieces of support instrumentation.

Occoquan Watershed Monitoring Laboratory (Manassas, Virginia)

The environmental science and engineering program also includes the Occoquan Monitoring Laboratory (Manassas, Virginia), where research focuses on runoff pollutant effects on receiving waters, reservoir eutrophication control, and watershed monitoring and management. Web

site: www.owml.vt.edu

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Virtual, Leesburg, Blacksburg, Richmond)

TOEFL

Paper: (570.0)

iBT: (88.0)

GRE

General: Verbal, Quantitative, Analytical

MS ESEN degree may be taken either as coursework only or with the permission of the faculty may incorporate a research thesis. See Departmental Manual:http://www.cee.vt.edu/current_students/files/grad_policy_and_manual.pdf

INDUSTRIAL AND SYSTEMS ENGINEERING

Gaylon Taylor, Head

Professors: John Casali; Brian Kleiner; Maury Nussbaum; Subhash Sarin; Robert Sturges; Gaylon Taylor; Konstantinos Triantis; Eileen Van Aken;

Associate Professors: Douglas Bish; Ebru Bish; Jaime Camelio; Kimberly Ellis; Joseph Gabbard; Lawrence Harmon; Charles Koelling; Zhenyu Kong; Joel Nachlas; Raghu Pasupathy; Hazhir Rahmandad; John Shewchuk; Michael Taaffe;

Assistant Professors: Michael Agnew; Xi Chen; Navid Ghaffarzadegan; Ran Jin; Nathan Lau; Diego Moran; Christian Wernz;

Rolls Royce Commonwealth Professor of Advanced Manufacturing: Jaime Camelio;

John Grado Professor: John Casali;

Ralph H. Bogle Jr. Professor: Brian Kleiner;

Hal G. Prillaman Professor: Maury Nussbaum;

Paul T. Norton Endowed Professor: Subhash Sarin;

Charles O. Gordon Professor: Gaylon Taylor;

John Lawrence Professor: Konstantinos Triantis;

Main Campus Graduate Program Contact: hannah.parks@vt.edu

Off Campus Graduate Program Contact: pcuren@vt.edu

Graduate Site: http://www.ise.vt.edu/GraduatePrograms/Graduate_Programs.html

Main Website: <http://ise.vt.edu/index.html>

Student Handbook:

http://www.ise.vt.edu/GraduatePrograms/AdditionalDocuments/GradManual_pdf.pdf

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Graduate Admissions Information:

The Grado Department of Industrial and Systems Engineering (ISE) offers a broad-based program allowing students to pursue graduate study commensurate with their career goals. Specific strengths of the program are in the areas of human factors engineering and ergonomics, general industrial engineering, management systems engineering, manufacturing systems engineering, operations research, engineering administration, and systems engineering. The Ph.D. degree is offered in Industrial and Systems Engineering, and the master's is offered in Industrial and Systems Engineering (M.S.), Engineering Administration (M.E.A.), and Systems Engineering (M.S.).

SPECIAL FACILITIES

Creating and maintaining state-of-the-art facilities is one of the most challenging aspects of a top 10 ISE department. Through private giving, research sponsorship, equipment donations and state support, we strive to provide the very best technology for our students and sponsors. For more information on our many labs, centers and other facilities, see the facilities page of the ISE web site:

http://www.ise.vt.edu/ResearchFacilities/ResearchFacilities_index.html

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (400.0), Quantitative (650.0), Analytical (3.5)

MS (non-thesis) must take 30 hours of coursework beyond the B.S. MS (thesis) must take 30 hours with a minimum of 20 hours of course work beyond the B.S..

Degree Concentrations:

Human Factors Engineering and Ergonomics

http://ise.vt.edu/GraduatePrograms/MS/HFEE/MS_HFEE_index.html

Management Systems Engineering

http://ise.vt.edu/GraduatePrograms/MS/MSE/MS_MSE_index.html

Manufacturing Systems Engineering

http://ise.vt.edu/GraduatePrograms/MS/ManufacturingSystems/MS_ManufacturingSystems_index.html

Operations Research

http://ise.vt.edu/GraduatePrograms/MS/OR/MS_OperationsResearch_index.html

International Degree Program with Ecole des Mines de Nantes

http://ise.vt.edu/GraduatePrograms/InternationalPrograms/International_Dual_Masters_Degree/MS_InternationalDualDegree_index.html

General Industrial Engineering

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (400.0), Quantitative (650.0), Analytical (3.5)

PHD must take 90 hours with a minimum 45 hours of course work beyond the B.S.

Degree Concentrations:

http://ise.vt.edu/GraduatePrograms/PhD/Human_Factors_Ergonomics/Human_Factors_Ergonomics_FEE_index.html

MEA Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Roanoke, Richmond)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

General: Verbal (400.0), Quantitative (650.0), Analytical (3.5)

MEA must take 30 hours of coursework beyond the B.S.

GRADUATE COURSES (ISE)

ISE 5015:

Management of Change, Innovation, and Performance in Organizational Systems

The management (planning, measurement and evaluation, control, and improvement) of organizational systems (work groups, departments, functions, plants, and companies). 5015: Managing performance, change, and innovation in organizational systems. 5016: Measurement and evaluation of performance or organizational systems. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5016:**Management of Change, Innovation, and Performance in Organizational Systems**

The management (planning, measurement and evaluation, control, and improvement) of organizational systems (work groups, departments, functions, plants, and companies). 5015: Managing performance, change, and innovation in organizational systems. 5016: Measurement and evaluation of performance or organizational systems. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5024:**ISE Seminar**

Discussion of research projects and results of sponsored and other research in the ISE Department and elsewhere, including descriptions of specialized equipment and facilities. In addition orientation to the department, its organization and operation is provided. I

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5034:**Mathematical Probability and Statistics for Industrial Engineers**

One-semester mathematical foundations for graduate study of engineering oriented probability and statistics. Re-introduces probability in a rigorous mathematical fashion and re-introduces mathematical statistics as an application of mathematical probability. Establishes a solid mathematical foundation for the type of probability (and statistics) modeling and analysis that is characteristic of graduate industrial engineering curricula and practice. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5044:**Production Systems Analysis**

Principles, models, and methods for addressing operational problems in manufacturing systems. Application of fundamental measures such as cycle time, throughput, capacity, work-in progress, inventory, and variability for understanding, controlling and optimizing performance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5034, ISE 5405

Corequisite(s):

ISE 5104:**Operations Research**

Basic techniques and methods of Operations Research are presented.

The course will cover the phases of problem identification, model building and analytical methods of decision making. Students will be introduced to the implementation of these algorithms and models. Not for credit for students pursuing the M.S. or Ph.D. in the O.R. option.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5114:**Case Studies in Industrial Engineering**

Applications of the methodologies in Industrial Engineering and Operations Research to actual problems in Business, Industry and Government operations. The study will cover all the phases of analysis, problem description, system structure, model development and validation and solution techniques. Student involvement in the case studies will be accomplished through project assignments. Not for credit for M.S., M.E., or Ph.D. degrees in ISE.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ISE 5104, ISE 5434, STAT 5004

Corequisite(s):

ISE 5124:**Management of Quality and Reliability**

This course presents the managerial and mathematical principles and techniques of planning, organizing, controlling, and improving the quality and reliability functions of an organization. The approach taken is to

study the management of quality and reliability through the product life cycle, i.e., from research and development, through testing and analysis.

The implementation of the managerial and mathematical techniques will be achieved through the study of selected case studies.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): STAT 5004

Corequisite(s):

ISE 5134:

Management Information Systems

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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5144:

Performance and Productivity Measurement and Evaluation

This course presents the principles and techniques of performance management at the organizational level. Emphasis is placed on the measurement of performance with a focus on productivity measurement, as well as on performance evaluation and how these areas facilitate performance planning, control and improvement. Each student will be required to complete a project which will emphasize the application of these techniques to an organizational setting.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5154:

Applied Human Factors Engineering

An examination of present human engineering design criteria, principles, and practices to achieve mission success through integration of the human into system, subsystem, equipment, and facility design in order to achieve effectiveness, simplicity, efficiency, reliability and safety of system operation, training and maintenance. Not for credit for students

pursuing the M.S. or Ph.D. in the Human Factors option.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5164:

Transfer and Application of Emerging Technology

Transfer of emerging technological developments from scientific discovery and invention through product development, leading to value-added applications in private sector and government enterprises. Market and technological research, forecasting, test and evaluation, outsourcing R & D, community/government support programs, legal protection and regulation of intellectual property, economic development, economic risk and similar issues supporting the management of technological innovation. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5174:

Engineering Program and Project Management

The project approach as applied in the accomplishment and management of complex technical work typically performed by engineers, scientists and other technology professionals. Practical application and ongoing enhancement of program and project management systems with emphasis on process, techniques, standards, empirical guidelines, computer software, teamwork and economic considerations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5204:

Manufacturing Systems Engineering

Conceptual models of manufacturing, process, and service organizations for various operational levels are presented. Functional activities and interrelationships are defined for each type of manufacturing model.

activities, particularly production planning/control, materials management, facilities design/material handling, manufacturing engineering, quality control, and personnel administration.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5244:

Facilities Planning and Material Handling

Application of decision theory and operations research techniques in development of mathematical models to specific study areas of facilities planning and material handling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 2404, ISE 3414

Corequisite(s):

ISE 5264:

Modeling and Analysis of Semiconductor Manufacturing

This course will present the modeling and analytical concepts and techniques used for the operational control of a semiconductor manufacturing facility. This will include the following: introduction to wafer fabrication, distinct features of a wafer fab, modeling techniques, planning and operational control problems in a wafer fab, lot sizing, and assembly test and packaging.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s): ISE 5204, ISE 5405

ISE 5314:

Industrial Applications of Robotics Devices

Technical aspects of robotics devices and automation islands employed by the industry are discussed in detail. On-line job teaching and off-line job planning for the industrial robot are compared. Various industrial applications including spray painting, welding, machine loading, and assembly are studied.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ISE 4264

Corequisite(s):

ISE 5405:

Optimization

5405: Linear programming, modeling, assumptions, and structural properties; primal, dual, and primal-dual simplex algorithms; convergence and implementation issues; duality theory; sensitivity and parametric analysis; linear multiobjective and goal programming, introduction to integer, dynamic, and nonlinear programming. 5406: Nonlinear programming theory and algorithms: convex sets and functions, generalized convexity; and theorems of the alternative, constraint qualifications, necessary, and/or sufficient optimality conditions. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5406:

Optimization

5405: Linear programming, modeling, assumptions, and structural properties; primal, dual, and primal-dual simplex algorithms; convergence and implementation issues; duality theory; sensitivity and parametric analysis; linear multiobjective and goal programming, introduction to integer, dynamic, and nonlinear programming. 5406: Nonlinear programming theory and algorithms: convex sets and functions, generalized convexity; and theorems of the alternative, constraint qualifications, necessary, and/or sufficient optimality conditions. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405

Corequisite(s):

ISE 5414:

Random Process

Stochastic processes of use in many areas of study, specifically industrial engineering and operations research. Emphasis on Markov processes. Applications will be given.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 4105

Corequisite(s):

ISE 5424:

Simulation I

Introduction to discrete event digital simulation, including development of simulation models, random number and random variable generation, model validation and testing, analysis of model output, and an overview of simulation languages. Emphasizes the use of simulation modeling in decision-making through a series of projects involving decision problems. Knowledge of programming required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): STAT 4105

Corequisite(s):

ISE 5434:

Economic Evaluation of Industrial Projects

Application of engineering economy to the economic evaluation of industrial projects. In general, these projects will include investment in the new facilities as well as replacement of old facilities. Concepts of wealth maximization, utility, and risk will be discussed. Financing will be treated as an integral part of the investment problem.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5454:

Production Planning and Control

Introduction to the mathematical analysis of various aspects of production planning and control. Among others, this includes topics in inventory control, forecasting, aggregate production planning, production and project scheduling, and line balancing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405

Corequisite(s):

ISE 5464:

Queueing Theory

Classic models of queues including M/M/1, M/GI/1, and GI/M/s. Topics in queue length processes, waiting time processes, busy period processes, and traffic processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5414

Corequisite(s):

ISE 5474 (STAT 5474):

Statistical Theory of Quality Control

Development of statistical concepts and theory underlying procedures used in quality control applications. Sampling inspection procedures, the sequential probability ratio test, continuous sampling procedures, process control procedures, and experimental design. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): STAT 5104, STAT 5114

Corequisite(s):

ISE 5604:

Human Information Processing

An examination of human information reception, information processing, and skilled performance capabilities and limitations in human-machine systems with an emphasis on models and techniques, including psychophysics, signal detection theory, information theory, supervisory control, and decision theory.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5605:

Human Factors System Design

Human factors input into operator-system design, development, testing, and evaluation. Emphasis on the systems approach to human-machine interfacing, with discussion and application of specific methodologies and analytical techniques. Display and control design and selection fundamentals with engineering modeling of manual control systems. In

systems analysis and design techniques. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 3614

Corequisite(s): null null

ISE 5606:

Human Factors System Design

Human factors input into operator-system design, development, testing, and evaluation. Emphasis on the systems approach to human-machine interfacing, with discussion and application of specific methodologies and analytical techniques. Display and control design and selection fundamentals with engineering modeling of manual control systems. In 5606, each student performs a design project relying on application of systems analysis and design techniques. II

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5605

Corequisite(s): null null

ISE 5614 (BMES 5214):

Human Physical Capabilities

Focuses on the modeling, analysis, and evaluation of industrial workplaces with emphasis on the physical demands placed on and the capabilities of workers. Topics covered include: physiology, anthropometry, bioinstrumentation, and biomechanics. Students will learn and apply a range of contemporary analytical and assessment methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 3614

Corequisite(s):

ISE 5615:

Human Factors Research Design

Procedures for conducting and analyzing human factors and ergonomics experiments, including fundamentals of research, design alternatives, fitting and testing statistical models, and data interpretation and presentation. Primary focus on linear regression (simple and multiple) and analysis of variance (single and multiple factor). Second course in the sequence addresses advanced topics in the theory and application

of experimental design and statistical analysis in human factors and ergonomics. Graduate standing required. 5615: I; 5616: II.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5616:

Human Factors Research Design

Procedures for conducting and analyzing human factors and ergonomics experiments, including fundamentals of research, design alternatives, fitting and testing statistical models, and data interpretation and presentation. Primary focus on linear regression (simple and multiple) and analysis of variance (single and multiple factor). Second course in the sequence addresses advanced topics in the theory and application of experimental design and statistical analysis in human factors and ergonomics. Graduate standing required. 5615: I; 5616: II.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5615

Corequisite(s):

ISE 5634:

Training System Design

A systems approach to the design and development of training, with emphasis on techniques to conduct training-needs analysis; a survey of training technology with an emphasis on computer-assisted techniques and training simulators; and procedures to evaluate training effectiveness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5605, ISE 5616

Corequisite(s):

ISE 5644:

Human Audition and Auditory Display Design

An examination of the human sensory and perceptual experience of sound, with emphasis on relating the capabilities and limitations of audition to the design of auditory display systems and to noise abatement in hearing conservation efforts. In addition to discussion of human sound reception and sensitivity, human psychological and

physiological responses to sound will be covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 3614

Corequisite(s):

ISE 5674:

System Safety Analysis

The analytical techniques and documentation requirements to provide proper design of equipment and systems and to protect against products liability. Safety concepts, legal concepts, qualitative and quantitative hazard evaluation, hazard classification, system life cycle safety, statistical distributions, software safety analysis, inductive and deductive analysis, Mort, Fault Tree, hands-on projects emphasizing hazard identification and control.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 4644, (STAT 3604 OR STAT 4105)

Corequisite(s):

ISE 5684:

Industrial Health and Safety Engineering

Identification, analysis and control of biological, chemical, electrical, radiation, and fire hazards in industrial settings. Hands-on analysis of several "case-study" projects associated with these hazards in a variety of settings. Recognizing and measurement of hazards, prioritize hazards for control, select effective control methodologies and evaluate the effectiveness of implemented controls.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 4644, (STAT 3604 OR STAT 4105)

Corequisite(s):

ISE 5694:

Macroergonomics

The optimization of work system design through consideration of relevant personnel, technological, and environmental variables and their interactions. Emphasis is on the theoretical background, research methods, analyses, design, development and applications of work systems and the relationship between macro- and micro-ergonomics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5714 (CS 5714):

Usability Engineering

Design and evaluation of effective user interfaces, beginning with principles for designing the product. Development process for user interaction separate from interactive software development.

Development process includes iterative life cycle management, systems analysis, design, usability specifications, design representation techniques, prototyping, formative user-based evaluation. Integrative and cross-disciplinary approach with main emphasis on usability methods and the user interaction development process. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ISE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

399 Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ISE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ISE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ISE 6014:

Proposing Industrial Engineering Research

Processes involved with proposing research in industrial engineering. Methods and approaches to generate effective proposals. Alternative mechanisms involved in identifying and proposing research. Material is examined through several exercises and case studies. Course is intended for second- year doctoral students who have completed the preliminary exam but have not yet defended the proposal. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 6024:

Advanced Topics in Management Systems Engineering

A research-oriented course reviewing the engineering literature in management systems engineering of selected complex systems, structures, and techniques. Industrial, service, governmental, and health care systems will be considered. State-of-the-art topics will be examined to an extent not covered in other courses. May be repeated, with different content, for a maximum of nine credit hours.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

ISE 6054:

Decision Theory

Principles, models, and methods of decision theory. Focus on normative decision theory (how rational agents make decisions), prescriptive aspects (helping people make better decisions) and descriptive aspects (how people actually make decisions) including utility theory, decision analysis, risk modeling, game theory, multiscale decision theory, analytical hierarchy process, Bayesian networks, and real options theory.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5024

Corequisite(s):

ISE 6284:

Advanced Topics in Manufacturing Systems Engineering

A research-oriented course reviewing the topics and scientific literature in manufacturing systems analysis, design, and control. State-of-the-art topics may include: manufacturing systems design and control, facility logistics, production planning and scheduling, inventory control, manufacturing systems modeling, and materials management. May be repeated with different content for a maximum of 9 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5204, ISE 5405, ISE 5424

Corequisite(s):

ISE 6404:

Graph Theory and Network Flows

Graph theoretic concepts and definitions, optimization problems over graphs, and basic results; minimum cost network flow problems (including assignment, transportation, max flow, and shortest-path problems) and associated algorithms with implementation strategies; PERT and CPM; and network design and synthesis problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405

Corequisite(s):

ISE 6414:

Integer Programming

Modeling with integer variables; enumeration and cutting plane methods; partitioning and relaxation techniques; computational complexity issues; and some special combinatorial optimization problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405

Corequisite(s):

ISE 6424:

Dynamic Programming

Introduction to the theory, applications, and computational aspects of dynamic programming. Markovian decision processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405, ISE 5414

Corequisite(s):

ISE 6434:

Scheduling and Sequence Theory

Theory of deterministic scheduling; sequencing of jobs on a single processor; multi-processor problems including flow shop and job shop scheduling; and introduction to the complexity of computations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405

Corequisite(s):

ISE 6444:

Inventory and Operations Management

A fundamental course on mathematical models designed to support production and inventory management, focusing on recent developments inspired by prominent managerial and engineering concerns. These developments include both innovative models and interesting new perspectives on older ones. One central theme is process improvement through reducing leadtimes and improving quality. Models reveal how process parameters affect system performance, and

thus estimate the economic benefits of improving them. Another central theme is the coordination of diverse activities, and the key role of inventories as buffers between them.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5405, ISE 5414

Corequisite(s):

ISE 6464:

Queueing Networks

Applications of queueing theory results to queueing networks. Topics include reversibility, insensitivity, product forms for queue length processes, and traffic processes including traffic flow within the network.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5464, ISE 6504

Corequisite(s):

ISE 6474:

Reliability Theory

An introductory graduate-level examination of mathematical models of failure processes and complex system reliability. Included are existing probability models of component and system failure processes, statistical and experimental methods for estimating failure behavior, and optimization models for supporting design, replacement, and maintenance decisions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5414, ISE 5405, STAT 5004

Corequisite(s):

ISE 6494:

Advanced Simulation

Introduction to advanced methods of analysis of simulation model output. Particular emphasis is placed upon the relationship between the decision process and model output. Topics include impact of non-normality, dependence, and transient behavior on model output; methods for identifying near steady-state behavior, batch means, sequential systematic sampling, regeneration method, and determination of simulation run length.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): STAT 4105, ISE 5614

Corequisite(s):

ISE 6514:

Advanced Topics in Mathematical Programming

Decomposition algorithms for large scale linear and nonlinear programs having special structures; algorithmic maps and convergence analysis; optimality conditions and duality in nonlinear programming; polynomial algorithms for linear programming problems; optimization theory and algorithms for nonsmooth and nonconvex nonlinear programs; calculus of variations and optimal control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5406

Corequisite(s):

ISE 6604:

Human Factors in Visual Display Systems

Quantitative analysis of human visual system capabilities and limitations, and their relationship to the design of visual display components and systems. Emphasis is placed on the measurement and physics of light, visual science data, hardware design, and the use of linear systems theory in display design and evaluation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5604, ISE 5605

Corequisite(s):

ISE 6614:

Human Computer Systems

A survey of human factors procedures used in the design of computer-based systems. Consideration is given to the iterative interface design process, hardware interface design, software interface design, and workplace design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5605

Corequisite(s):

ISE 6624:

Advanced Topics in Human Factors

A research-oriented course reviewing the scientific literature in Human Factors Engineering of selected complex systems. Industrial, civil, transportation, military and computer-based systems will be considered. State-of-the-art topics will be examined to an extent not covered in other courses. May be repeated, with different content.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5605

Corequisite(s):

ISE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ISE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MATERIALS SCIENCE AND ENGINEERING

David Clark, Head

Professors: David Clark; Norman Dowling; Diana Farkas; Robert Hendricks; Guo Quan Lu; Gary Pickrell; William Reynolds; Dwight Viehland;

Associate Professors: Alexander Aning; Levon Asryan; Sean Corcoran; Alan Druschitz; Earl Foster; Louis Guido; Peizhen Lu; Mitsuhiro Murayama;

Assistant Professors: Celine Hin; Abby Whittington;

Research Faculty: Jie-Fang Li; Sean McGinnis; Carlos Suchicital;

Adjunct Professors: Jeremiah Abiade; Michael Bortner; Dudley Finch; M Julian; Stephen Kampe; Michael Kelley; Kathryn Logan;

Affiliated Faculty: Romesh Batra; Christine Burgoyne; Scott Case; Rafael

Khai Ngo; Scott Renneckar; Thomas Staley; Roe Yoon;

Clifton C. Garvin Professor: Romesh Batra;**Graduate Contact:** grandska@vt.edu**Graduate Site:** <http://www.mse.vt.edu/>**Application Instructions:**<http://www.mse.vt.edu/GraduatePrograms/ApplicationInstructions/tabid/707/Default.aspx>

The Department of Materials Science and Engineering awards the M.S. (thesis required), the M.Eng. (non-thesis), and the Ph.D. in materials science and engineering. Candidates for these degrees must hold, or be pursuing, a degree in any branch of engineering, physics, chemistry, geological science, or mathematics. Specialization is available in: 1) structure and properties of crystalline and non-crystalline materials, 2) materials synthesis, processing, and fabrication, 3) theoretical understanding and computer modeling of materials structures, properties and processes, 4) phase transformations, 5) thermodynamics and phase equilibria, 6) diffusion and kinetics of solid state reactions, and 7) mechanical, thermal, electrical, optical, and magnetic property characterization of all material types, and 8) microelectronic and optoelectronic materials.

SPECIAL FACILITIES

Specialized laboratories permit research in the following areas: thermodynamics and phase equilibria; materials corrosion and stability; x-ray diffraction and crystal structure determination; phase transformations, precipitation hardening and diffusion in materials systems; electron (STEM, SEM, ESEM) and optical microscopy; mathematical modeling and computer simulation of structure, defects and processes; surface characterization of materials by ESCA; materials synthesis, processing and fabrication; characterization of residual stresses in materials, fabrication of thin film electronic and optical materials, mechanical alloying of metals; composite material fabrication and characterization; and electrical, optical, thermal, and mechanical property characterization of ceramics, metals, polymers and glasses including composites, thin films, dielectrics and semiconductors. A class 10,000 cleanroom is available for the preparation of microelectronic materials. Major research facilities include optical and transmission electron microscopy; an environmental scanning electron microscope; x-ray diffraction equipment including facilities for the measurement of residual stresses in materials; a secondary ion mass spectrometer, a photoelectron emission spectrometer, surface analysis instruments; mechanical testing frames; instruments for measuring the thermal response of materials including thermal expansion, thermal diffusivity, and differential thermal analysis; sputtering, thin film and vacuum deposition equipment; heat treatment and sintering furnaces; a metal melt spinner; mechanical alloying ball mills; dry and hot isostatic presses; electrical and dielectric characterization instruments; polymer processing and characterization equipment; and computer modeling and simulation facilities including access to multimedia and computer visualization facilities.

DEGREES OFFERED**MS Degree****TOEFL***Paper:* (550.0)*Computer:* (213.0)*iBT:* (80.0)

The M.S. degree requires a thesis. Students with an interest in applied research and development should consider this degree option. Like the M.Eng. degree, the M.S. requires the completion of 30 credit hours of work. Between 6 and 10 of these credit hours are on thesis research (MSE 5994). Most students spend two academic years completing the M.S. program of study. Students are encouraged to read our Graduate Student Manual, which can be found on our website, for more detailed information about our degree requirements.

MEng Degree

Offered In (Blacksburg)

TOEFL*Paper:* (550.0)*Computer:* (213.0)*iBT:* (80.0)

The M.Eng. is a non-thesis degree obtained through course work and a project that focuses on an industrial problem or critical literature review. Students with a baccalaureate degree who desire a professional-oriented master's degree and advanced undergraduate students who wish to supplement their background with additional course work are encouraged to consider the M.Eng. degree. A total of 30 credit hours are required for this degree; between 3 and 6 of these hours are project work (MSE 5904), the remainder are course credits. Students typically complete this degree in 12 to 18 months. Students are encouraged to read our Graduate Student Manual, which can be found on our website, for more detailed information about our degree requirements.

PhD Degree

Offered In (Blacksburg)

TOEFL*Paper:* (550.0)*Computer:* (213.0)*iBT:* (80.0)

The Ph.D. degree is intended for exceptional students who have a strong interest in scholarship and a desire to do independent research. This degree program is designed to be flexible to meet the broad interests of students and faculty. General requirements for the degree are those of the College of Engineering. A master's degree is neither a prerequisite nor a requirement. However, many Ph.D. students complete the requirements for a master's degree while working toward the Ph.D. degree. The Ph.D. requires the completion of 90 credit hours of work. Students are encouraged to read our Graduate Student Manual, which can be found on our website, for more detailed information about our degree requirements.

GRADUATE COURSES (MSE)

MSE 5014 (CHE 5014) (CHEM 5014):

Presentation Skills

Methods and style to make effective technical and nontechnical presentations including blackboard presentations, overhead presentations, slide presentations, and research posters. Video presentations with critiques.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5015:

Materials Science and Engineering Seminar

Materials Science and Engineering students are required to participate in Materials Science and Engineering Seminar during every semester of their residency. Masters of Science or Engineering students must present one seminar during the course of their studies; PhD students must present two seminars during their tenure. Provides training in the organization, preparation, and presentation of technical information. Pre: Graduate standing in MSE.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5016:

Materials Science and Engineering Seminar

Materials Science and Engineering students are required to participate in Materials Science and Engineering Seminar during every semester of their residency. Masters of Science or Engineering students must present one seminar during the course of their studies; PhD students must present two seminars during their tenure. Provides training in the organization, preparation, and presentation of technical information.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5024:

Mathematical Methods in Materials Research

Analytical and numerical techniques applied to problems in materials science. Translating physical information into a mathematical model, obtaining a solution by selecting and applying suitable mathematical methods, applying modern computing tools, and interpreting the meaning and implication of the mathematical solution in terms of the appropriate theories of materials science. An undergraduate science or engineering degree and mathematics through differential equations required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5034:

Structure and Properties of Materials

An introduction to descriptions of the structure of matter and materials properties. Bravais lattices, Miller indices, reciprocal space, stereographic projections, symmetry and crystal defects. Matrix methods for calculating crystal directions, lengths and angles. Tensor descriptions of properties. Diffraction and scattering from crystals. Undergraduate physical sciences or engineering degree is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5044:

Powder Processing

Processing methods associated with making consolidated components from powders. Preparation, blending, and compaction of metallic, ceramic, and polymeric powders. Solid-state and liquid-phase sintering. Laser and microwave sintering.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): , MSE 5165

Corequisite(s):

MSE 5054:

Advanced Materials Thermodynamics

relationships. Experimental and computational methods for the determination of the thermodynamic properties of alloys. Applications in alloying, heterogeneous reactions, and the thermodynamics of surfaces.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 4034

Corequisite(s):

MSE 5064:

Diffusion and Kinetics

Theories of diffusion mechanisms in solids. Solutions of governing differential diffusion equations. Classical nucleation theory, spinodal decomposition, diffusion-controlled growth kinetics, overall transformation kinetics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 5024, MSE 5054

Corequisite(s):

MSE 5104:

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. An undergraduate degree in engineering or science is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5114:

Introduction to Materials Characterization

Introduction to techniques used to characterize material structure and chemistry. Physical principles behind surface and microanalysis techniques and the information various techniques provide. X-ray, electron, ion, vibrational, and absorption spectroscopy and optical, electron, and acoustic microscopy. Undergraduate degree in physical sciences or engineering is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5124:

Materials Optimization Through Designed Experiments

Methods of analysis of variation in materials systems, in manufacturing or R&D, through the use of statistical methods including experimental design techniques (DOE) with instructional examples related to Materials Science and Engineering. Undergraduate physical sciences or engineering degree is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5134:

Introduction to Transmission Electron Microscopy

Introduction to physical science/inorganic materials oriented transmission electron microscopy and spectroscopy for student pursuing nanoscale characterization in materials science and related fields.

Overview of instrumentation and the working principles of transmission and scanning electron microscopes, introductory theories of electron diffraction, imaging and energy dispersive X-ray spectroscopy. Perform electron microscopy image and spectroscopy data interpretation via hands-on laboratory exercises. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

MSE 5144 (ESM 5144):

Deformation and Fracture of Materials

Deformation and fracture of engineering materials is considered in the context of solid mechanics and engineering methods for predicting strength and life. Topics include plasticity, failure criteria, fracture mechanics, crack growth, strain-based fatigue, and creep.

Microstructure-property relationships are discussed. Laboratory demonstrations of behavior in mechanical tests are included. Partially duplicates material in ESM 4024 and both should not be taken. II.

405 Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5164:

Principles of Corrosion and Electrochemical Processes

Introduction to the 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. Undergraduate physical sciences or engineering degree is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5174:

Advanced Physical Ceramics

Characteristics of vitreous and crystalline inorganic nonmetallic materials. Application and discussion of effects of composition and microstructure on thermal, mechanical, optical, electrical, and magnetic properties of ceramic products.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5184:

Materials Modeling and Simulation

Computer modeling and simulation of diffusional and diffusionless processes active in the microstructural development of engineering materials; including spinodal decomposition, precipitation, sintering, ordering, grain growth, martensitic transformations, and ferroelectric and ferromagnetic domain evolution. Thermodynamics and kinetics of phase transformations; analytical and numerical mathematical methods; diffuse interface field approach; multi-physics modeling; multi-scale modeling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 5024

Corequisite(s):

MSE 5200 (ECE 5200):

Semiconductor Alloys and Heterostructures

Advanced treatment of semiconductor materials with an emphasis on binary compounds, ternary and quaternary alloys, and strained-layer structures. Topics include crystal structure; lattice vibrations and phonons; energy band structure; equilibrium and non-equilibrium carrier distributions; electron and hole transport via diffusion and drift; and carrier generation and recombination mechanisms. Graduate standing required in the College of Engineering or College of Science.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 3204 (UG) OR PHYS 3455 (UG) OR ECE 4214 (UG) OR MSE 3204 OR PHYS 3455 OR ECE 4214

Corequisite(s):

MSE 5214:

Optoelectronic and Magnetic Applications

This course will introduce the field of man-made modifications in the properties of materials obtained by controlled growth of structures of nearly atomic dimensions. Devices which utilize these properties will be studied. The course will emphasize the relationships between advanced materials growth technologies, new materials properties, physics concepts and new devices. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 4206 OR MSE 4216

Corequisite(s):

MSE 5224:

Photonic Materials

An introduction to materials used in the generation, propagation and harnessing of light for useful applications. An emphasis on understanding the structure of materials including glasses, single crystals, and polycrystalline materials, and their effects on the propagation of electromagnetic energy. Luminescence (including phosphorescence and fluorescence), refractive index, transmission, absorption, reflection, origin of color in materials, fiber optics, dispersion,

nonlinear effects, lasers, LEDs, detectors, numerical aperture, attenuation coefficients, Rayleigh scattering, infrared absorption spectra, holey fibers, and photonic crystals. Undergraduate degree in engineering or science is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5234:

Introduction to the Materials Science of Surfaces and Interfaces

Fundamental and applied aspects of surfaces. Solid/solid, solid/liquid, and solid/vapor interfaces. Their structure and defects, thermodynamics, reactivity, electronic and mechanical properties. Applications depend upon class interests, but can include microelectronics, soils, catalysis, colloids, composites, environment-sensitive mechanical behavior, UHV single crystal studies, materials durability and surface bioactivity. Pre-requisite: Undergraduate degree in physical sciences or engineering.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 5034, MSE 5054

Corequisite(s):

MSE 5254:

Science and Technology of Thin Films

Fundamental properties and microstructure of materials in thin film (thin coating) form, their interaction with a substrate, thin film processing/characterization techniques, and instrumentation. Areas of application have been selected to exemplify the interdisciplinary nature of the field and include the electronics, biomedical, military, aerospace and construction industries. Undergraduate degree in engineering or physical sciences is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5304:

Contemporary Topics in Materials Science and Engineering

Contemporary topics in materials research selected from technical literature or recent faculty research initiatives. Topics stress the

development of fundamental concepts and/or technologies of current interest to materials science and engineering. May be repeated for credit with different content for a maximum of 9 credit hours. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5314:

Materials Characterization Techniques

Fundamentals, instrumentation and practical application of characterization techniques. Scanning electron microscopy, energy dispersive x-ray spectrometry, x-ray photoelectron spectrometry, Auger electron spectrometry, Rutherford backscatter spectrometry, focused ion beam tools, scanned probe microscopy, secondary ion mass spectrometry. Training in practical aspects of theory and operation of materials characterization equipment. Pre: Graduate standing.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

MSE 5384G:

Advanced Nuclear Materials

Materials for nuclear applications with emphasis on fission reactors. Fundamental radiation effects on materials; material properties relevant to structural, moderator, reflector, blanket, coolant, control related structural systems. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5504:

Polymer Deformation and Fracture

Continuum, statistical and molecular response of polymers under mechanical loading conditions. Molecular determinations of modulus, molecular and mechanical mechanisms of crazing and crack propagation, analytical methods relating molecular, micromechanical and mechanical response in polymers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 4554, MSE 4564, ESM 4024

Corequisite(s):

MSE 5574G:

Biomaterials

Biomaterials for medical 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. Materials for orthopedic, cardiovascular, and drug delivery applications. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5584:

Biomimetic Material Design

The application of the structure property relationships in biological materials such as wood, bone, shells, spider silk, connective tissue, blood vessels, and jellyfish as a means to design new materials.

Proteins and polysaccharides, biosynthesis and assembly, biomineralization, hierarchical organization. Introduction to tissue engineering and regenerative medicine. Life cycle, environmental aspects of biofabrication. Structural characterization of biological materials. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5614:

Advanced Nanomaterials

Synthesis of 0-dimensional nanoparticles, 1-dimensional nanotubes, nanowires, and nanorods; 2-dimensional nanoribbons and nanofilms, and specialized nano-features on substrates. Characterization of nanomaterials. Processing into higher order dimensions. Chemical, physical, mechanical, and electrical properties of nanomaterials. Application of nanomaterials.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 5054

Corequisite(s):

MSE 5624:

Design of Materials

The design of materials through the application of microstructural based structure/property relationships. Emphasis on the use of phenomenological and theoretical structure-property-processing relationships as means to guide material design. The influence of scale (nano, micro, meso, macro) on property development and material behavior. Pre: Graduate standing and/or an undergraduate physical sciences or engineering degree.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5634:

Design with Materials

The role and implications of material properties, processing, and structure in engineering design. The role of material selection in the conceptualization, specification, and implementation phases of the design process. Case studies in state-of-the-art, material-limiting component design. Graduate standing required and an undergraduate physical sciences or engineering degree.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5654:

Adhesion Science

Introduction to basic principles of adhesion science from the areas of mechanics, materials, and chemistry. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MSE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MSE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

MSE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

MSE 5994:

Research And Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MSE 6214:

Semiconductor Nanostructures

In-depth self-consistent coverage of semiconductor nanostructures with an emphasis on low-dimensional heterostructures, such as quantum wells, quantum wires, quantum dots, and superlattices. Electronic and optical properties of nanostructures; tunneling in nanostructures; quantum phenomena in nanostructures in electric and magnetic fields; and two dimensional electron gas.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 5200

Corequisite(s):

MSE 6304:

Advanced Topics in Materials Science

Advanced topics selected from the technical literature that stress the development of fundamental concepts and/or technologies of contemporary interest to materials science and engineering. Topics will vary; may be repeated for credit.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): MSE 5024, MSE 5034

Corequisite(s):

MSE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MECHANICAL ENGINEERING

Danesh Tafti, Interim Head

Emeriti Faculty: James Mahan;

Professors: Mehdi Ahmadian; Francine Battaglia; Richard Benson; Ricardo Burdisso; Thomas Diller; Srinath Ekkad; Christopher Fuller; Tomonari Furukawa; Alireza Haghighat; John Kennedy; Andrew Kurdila; Roop Mahajan; Douglas Nelson; Wing Fai Ng; Walter O'Brien; Robert Parker; Ranga Pitchumani; Corina Sandu; Danesh Tafti; Michael von Spakovsky;

Associate Professors: Jan Helge Bohn; Clinton Dancey; Michael Ellis; John Ferris; Warren Hardy; Scott Huxtable; Mary Kasarda; Kevin Kochersberger; Alan Kornhauser; Brian Lattimer; Alexander Leonessa; Rolf Mueller; Mark Paul; Mark Pierson; Shashank Priya; Michael Roan; Steve Southward; Saied Taheri; Brian Vick; Robert West; Alfred Wicks;

Assistant Professors: Javid Bayandor; Bahareh Behkam; Lissett Bickford; Celine Hin; Yang Liu; Reza Mirzaeifar; Amrinder Nain; Rui Qiao; Pablo Tarazaga; Zhiting

Tian; Christopher Williams; Leigh Winfrey; Lei Zuo;

Affiliated Faculty: Masoud Agah; Romesh Batra; Brenda Brand; Rafael Davalos; Raffaella De Vita; William Devenport; David Dillard; William Ducker; Stefan Duma; Hampton Gabler; John Grant; Muhammad Hajj; Dennis Hong; Sunghwan Jung; Donald Leo; Kevin Lowe; Lin Ma; Michael Madigan; Partha Mukherjee; Maury Nussbaum; Michael Philen; Robert Prins; John Robertson; Shane Ross; Gary Seidel; John Socha; Mark Stremmer; Robert Sturges; Costin Untaroiu; Pavlos Vlachos; Craig Woolsey;

Paul & Dorthea Torgresen Chair: Richard Benson;

John R Jones III Faculty Fellow: Michael Ellis; Michael Roan;

Samuel P. Langley Professor: Christopher Fuller;

W. Martin Johnson Professor: Andrew Kurdila;

Lewis A. Hester Chair in Engineering: Roop Mahajan;

Christopher C. Kraft Endowed Professor of Engineering: Wing Fai Ng;

John R. Jones III Professor: Ranga Pitchumani;

J. Bernard Jones Professor: Walter O'Brien;

William S. Cross Professor of Engineering: Danesh Tafti;

Clifton C. Garvin Professor: Romesh Batra;

L.S. Randolph Professor in Mechanical Engineering: Robert Parker;

General Contact: megrad@vt.edu

Graduate Coordinator: hillcath@vt.edu

Graduate Chair: mroan@vt.edu

ME Department Site: <http://www.me.vt.edu>

ME Graduate Studies Guide: <http://www.me.vt.edu/academic-programs/graduate-program/graduate-studies-guide/>

ME Research Centers: <http://www.me.vt.edu/people/faculty/research/centers-and-labs/>

Bursar's Office: <http://www.bursar.vt.edu>

University Scholarships and Financial Aid: <http://www.finaid.vt.edu/>

Timetable of Classes:

https://banweb.banner.vt.edu/ssb/prod/HZSKVTSC.P_DisRequest

Medical Insurance: <http://graduateschool.vt.edu/life/health/insurance>

Fellowships and Scholarships:

http://graduateschool.vt.edu/financial/fellowships_scholarships

Dates & Deadlines: <http://graduateschool.vt.edu/academics/deadlines>

College of Engineering: <http://www.eng.vt.edu/>

Housing: <http://www.housing.vt.edu/>

New Student Guide: <http://graduateschool.vt.edu/studentguide>

Graduate Student Veterans:

http://www.veterans.vt.edu/Graduate_Students/index.html

Historical Timetable of Classes:

https://banweb.banner.vt.edu/ssb/prod/HZSKVTSC.P_DisHistorical

ME Research Labs: <http://www.me.vt.edu/people/faculty/research/labs/>

The mission of the graduate program in Mechanical Engineering at Virginia Tech is to prepare students to advance the practice of mechanical engineering, and to expand and apply the body of

knowledge that comprises the discipline of mechanical engineering for the benefit of our students, research sponsors, the technical community, and ultimately our society. This mission is accomplished through the high-quality instruction, guidance, and mentoring of our graduate students. With over fifty faculty members, the Department of Mechanical Engineering offers advanced study and research in a wide range of areas leading to the PhD, MS, and MENG degrees. Each student, in cooperation with his or her advisory committee, develops a plan of study including research and course selection. The plan of study includes courses appropriate to the student's individual interests and research needs. Courses within the department that reflect many of the research focus areas include topics on fuel cell systems, nuclear engineering, biomedical topics, acoustics, active materials/smart structures, propulsion, thermodynamics, nanotechnology, automatic controls, rotor dynamics, turbomachinery, fluid dynamics, combustion, heat transfer, finite elements in machine design, and vibrations among other subjects. Students often take courses from outside the department in mathematics, statistics, and many other disciplines, both in the College of Engineering and in other colleges. The Mechanical Engineering Department also has an international collaboration with the Technische Universität Darmstadt for a dual Master of Science degree. A Nuclear Engineering Graduate Certificate is available for students to pursue, in conjunction with their graduate degree program.

SPECIAL FACILITIES

To facilitate research advances, the department has a number of specialized laboratories housing a substantial collection of sophisticated instrumentation and equipment. These laboratories include an anechoic chamber, a reverberation room, a gas turbine test cell, a fuel cells systems laboratory, a mechatronics laboratory, a rapid prototyping laboratory, a thermal radiation laboratory, a computer-aided design laboratory, a combustion laboratory, impact biomechanics laboratory, and a laser dynamics imaging laboratory among others. Many of these laboratories support one or more of the seven research centers and 25+ laboratory groups which are headquartered in the department. A list of Centers and research groups are listed below, including links to the web sites.

Advanced Experimental Thermofluids Engineering Research Laboratory

The Advanced Experimental Thermofluids Engineering Research Laboratory (AETHER). AETHER specializes in the development and application of advanced and novel experimental fluid mechanics methods for spatio-temporally resolving complex thermo-fluids systems.

Advanced Materials And Technologies Laboratory

The Advanced Materials And Technologies Laboratory (AMT) focuses on issues pertaining to the design and manufacturing science of advanced materials.

Advanced Vehicle Dynamics Laboratory

The Advanced Vehicle Dynamics Laboratory (AVDL) conducts innovative research and product development in advanced vehicle technologies toward improving the sponsors' products and market share, and provides a productive environment for educating both graduate and undergraduate students to better serve their future employers.

Biotransport & Optics Laboratory

The mission of the Biotransport and Optics Lab is to engage in

translational research at the intersection of biomedical tissue optics, device design, and heat and mass transport.

Center for Automotive Fuel Cell Systems

The mission of the Center for Automotive Fuel Cell Systems is to promote and facilitate education and research in the area of systems and components for transportation applications of fuel cell systems.

Center for Energy Systems Research

The mission of the Center for Energy Systems Research is to promote and facilitate education and research in the energy domain and to impartially serve the citizens of the Commonwealth of Virginia, the nation, and the international community by assisting them with energy issues.

Center for Injury Biomechanics - Virginia Tech/Wake Forest

The Center for Injury Biomechanics (CIB) performs research investigating human tolerance to impact loading. The application of this research includes automobile safety, military restraints, and sports biomechanics.

Center for Intelligent Material Systems and Structures

The Center for Intelligent Material Systems and Structures (CIMSS) focuses on the design and modeling of actuators and damping devices, as well as infrastructure health monitoring and diagnostics using structures and active materials.

Center for Tire Research

The Center for Tire Research (CenTiRe) focuses on supporting a research program in tire materials, modeling, manufacturing, and testing combined with rubber material prototyping and testing, and parallel computing and dynamic simulation capabilities.

Center for Turbomachinery and Propulsion Research

The Center for Turbomachinery and Propulsion Research (CTPR) at Virginia Tech has provided research and educational service to industry and government agencies for nearly 30 years.

Center for Vehicle Systems & Safety

Center for Vehicle Systems and Safety (CVeSS) is engaged in a wide variety of research ranging from advanced vehicle suspensions, to measurement and modeling of terrain and terramechanics, to biodynamics, to dynamic control of vehicle systems, to vehicle stability and rollover analysis.

Computational Research for Energy Systems and Transport Laboratory

Computational Research for Energy Systems and Transport Laboratory (CREST): The CREST team focuses on research to understand and apply fundamental knowledge to solve problems of importance in fluid and thermal sciences using computational fluid dynamics (CFD). Research efforts involve developing and validating computational models to represent processes of scientific and engineering interest. Primary research areas during the last 10 years include building energy and efficient energy utilization, alternative energy production, turbulent

and reacting multiphase flows, and combustion.

Design, Research & Education of Additive Manufacturing Systems Laboratory

The research mission of the Design, Research & Education of Additive Manufacturing Systems Laboratory (DREAMS) is to be a leader in the transition of rapid prototyping technologies to the new paradigm of additive manufacturing.

EXTREME Laboratory

The EXTREME Laboratory is an interdisciplinary laboratory where experimental and computational research is performed on material response at high temperatures and loads as well as combustion and fire dynamics processes.

Heat, Energy and Fluids Transport Laboratory

Heat, Energy and Fluids Transport Laboratory (HEFT) was established in August 2007 and deals with various Thermal/Fluids issues in the Gas Turbine Industry, Power Electronics, and Heat Exchangers. Our focus is on the development of methodologies and designs to solve real problems using fundamental understanding of thermal-fluid sciences and experimental and computational tools.

High Performance Computational Fluid Thermal Science and Engineering Group

The High Performance Computational Fluid Thermal Science and Engineering Group focuses on research in the advancement and application of computational methods and tools to aid the physical understanding of complex engineering fluid-thermal flows.

Intelligent Transportation Laboratory

The mission of the Intelligent Transportation Laboratory (ITL) is to improve the road transportation safety through development and application of the state-of-the-art sensors, actuators, and control systems.

Mechatronics Lab

The Mechatronics Laboratory focuses on creating practical engineering solutions by integrating sensors and microcontrollers in to military and medical applications.

Micro/NanoScale Biotic/Abiotic Systems Engineering Laboratory

The mission of the Micro/NanoScale Biotic/Abiotic Systems Engineering Laboratory (MicroN BASE) is to study and understand actuation, sensing and control mechanisms of microorganisms and apply the findings to design and fabricate biologically integrated and/or inspired microscale engineering systems.

Modal Analysis Laboratory

The Modal Analysis Laboratory specializes in research relating to the characterization of dynamic properties of structures.

Multi-Phase Flow Laboratory

The Multiphase Flow Laboratory is dedicated to basic and applied research aimed at improving our understanding of multiphase flows. Our research has concentrated on single-component liquid-vapor flows for

energy conversion systems.

Performance Engineering Research Laboratory

The mission of the Performance Engineering Research Laboratory (PERL) is to enhance the performance of sport, military, industrial, and commercial vehicles with the development and application of innovative active & adaptive control strategies. Our goal is to advance the state-of-the-art in vehicle suspension design, testing, and optimization with breakthrough innovations for improving vehicle ride and handling.

Railway Technologies Laboratory

The Railway Technologies Laboratory's mission is to explore and help implement technologies that will enable the U.S. railroad companies to become more efficient and competitive in their day-to-day operation.

Robotics & Mechanisms Laboratory

The Robotics & Mechanisms Laboratory (RoMeLa) at Virginia Tech is a facility for graduate and undergraduate robotics research and education with an emphasis on studying novel mobile robot locomotion strategies.

Rotor Dynamics Laboratory

The Rotor Dynamics Laboratory is involved with both analysis and experimental evaluation of rotating machinery design and vibration.

STEP Laboratory

The Spinneret based Tunable Engineered Parameters (STEP) is a pseudo dry spinning technique that allows the deposition of nano-micron sized diameter fibers with user defined control of diameter, spacing, and deposition angle.

Tissue Engineering, Nanotechnology, and Cancer Research Laboratory

Tissue Engineering, Nanotechnology, and Cancer Research Lab (TENCR) conducts research in many diverse areas. To facilitate rapid translation of our discoveries and technologies to the clinic, we have established multi-disciplinary collaborations with many exceptional academic researchers and industrial partners in addition to close synergy with physicians to develop the utility and impact of our technology.

Translational Oncology & Nano/Pharmacoengineering Laboratory

The Translational Oncology and Nano/Pharmacoengineering Lab works in a highly multi-disciplinary environment to solve problems in cancer diagnosis and treatment through the combination of existing and emerging technologies.

Unmanned Systems Laboratory

The Unmanned Systems Laboratory brings together a diverse collection of researchers to a common facility dedicated to autonomous and remotely operated systems development and integration.

Vehicle Terrain Performance Laboratory

The mission of the Vehicle Terrain Performance Lab (VTPS) is to improve vehicle system performance by studying the interactions between vehicles and terrain.

Vibrations & Acoustics Laboratory

The Vibrations and Acoustics Laboratory's (VAL) is one of the seven centers in the Mechanical Engineering Department. VAL's mission is to devote our research facilities to the solution of major scientific problems and to improving the quality of life in the communities that we serve.

One of our primary goals is to provide a foundation of knowledge, expertise and leadership in the field of sound and vibration control.

Virginia Active Combustion Control Group/ Reacting Flows Laboratory

The Reacting Flows Lab and the Virginia Active Combustion Control Group (RFL/VACCG) co-exists with the joint purpose of better understanding combustion and flow phenomena.

Virginia Tech Microelectromechanical Systems Laboratory

Virginia Tech Microelectromechanical Systems Laboratory (VT MEMS Lab) The current research at VT MEMS Lab centers on the development of CMOS-compatible three-dimensional silicon micromachining techniques, smart microchip coolers, micro gas analyzers for environmental and healthcare applications, and biochips for cancer diagnosis and cancer treatment monitoring. In addition, the lab is pursuing research to merge MEMS (top-down approach) and nanotechnology (bottom-up approach) in order to enhance the performance of the microsystems under development in our group.

DEGREES OFFERED

MEng Degree

Offered In (National Capital Region, Hampton Roads, Blacksburg)

TOEFL

Paper: (620.0)

Computer: (260.0)

iBT: (105.0)

GRE

General Test: Verbal (450.0), Quantitative (700.0), Analytical (550.0), Analytical Writing (4.5), Verbal (150.0), Quantitative (155.0)

Please contact megrad@vt.edu for specific location information. Acceptance into the VT Mechanical Engineering graduate program is based on the overall application package. In general, the minimum target requirements are to the left. The application materials required can be accessed from the ME application instructions web page. Master of Engineering (MENG) Degree Requirements The Master of Engineering Degree (MENG) in Mechanical Engineering is primarily intended for individuals working in industry/government, and pursuing this degree on a part-time basis. Masters' students must complete a minimum of 30 semester hours of graduate study beyond the baccalaureate. Because the MENG requires more coursework hours (24) and only project hours (6), departmental funding is not available. MENG students must submit a Plan of Study to the Graduate Coordinator before completing the first semester registered as a MENG student. The Master of Engineering Degree in Mechanical Engineering must include the following minimum requirements: 1. Engineering project and report (ME 5904): 6 hours minimum 2. Approved coursework meeting the following: 24 hours minimum * Courses numbered 5000

or higher: 18 hours minimum * ME Course Work: 9 hours minimum
* Courses outside the student's discipline area: 6 hours minimum *
ME approved Mathematics or Statistics: 3 hours minimum * A
maximum of two Virginia Tech 4000 level courses can be used to meet
degree requirements. * A maximum of 6 hours of Special Study
(5984 only), and a maximum of 6 hours of Independent Study (5974
only), with the total of both not to exceed 9 hours is allowed. *
Transfer courses meeting Graduate School policies, may be listed and
approved on the Plan of Study. A written Project & Report must
be submitted for the Final Defense. No courses below the 4000 level
will be accepted for graduate credit. Contact the ME graduate
program for approval procedures before taking any Special (5984
only) or Independent Study (5974 only) courses.

Degree Concentrations:

Nuclear Engineering Graduate Certificate

A student must take a total of at least 9 credit hours with a letter grade of
B or better in every course. Six credit hours must be from 5000-level
courses or higher. Required: NSEG 5114 Nuclear Engineering
Fundamentals: 3 credits Electives: Minimum 6 credit hours from the
approved course list (at least 3 credit hours must be at the 5000-level or
higher)

PhD Degree

Offered In (National Capital Region, Hampton Roads, Blacksburg)

TOEFL

Paper: (620.0)

Computer: (260.0)

iBT: (105.0)

GRE

General Test: Verbal (450.0), Quantitative (700.0), Analytical
(550.0), Analytical Writing (4.5), Verbal (150.0), Quantitative (155.0)

Please contact megrad@vt.edu for specific location information.
Acceptance into the VT Mechanical Engineering graduate program is
based on the overall application package. In general, the minimum
target requirements are to the left. The application materials required
can be accessed from the ME application instructions web page. Doctor
of Philosophy (PhD) Degree Requirements The Doctor of Philosophy
(PhD) in Mechanical Engineering requires that doctoral students must
complete a minimum of 90 semester hours of graduate study (with
stipulations listed below) beyond the baccalaureate, pass a qualifying
exam, and complete a research dissertation. PhD students must submit
a Plan of Study before completing the second semester registered as a
PhD student. Much of the course work from the Masters degree can be
used towards the PhD. The Plan of Study must meet the following
minimum requirements: Research & Dissertation (7994): 30 hours
minimum Approved Graduate Courses: 30 hours minimum Additional
hours of either research (7994) or coursework: 30 hours minimum
Courses numbered 5000 or higher: 27 hours minimum ME approved
Mathematics or Statistics: 3 hours post baccalaureate For continuously
enrolled VT students completing an MS, most or all coursework can be
used towards the PhD Transfer courses (including from a non-VT MS
degree) meeting Graduate School policies, may be listed and approved
on the Plan of Study. Independent/Special Study Courses (5974 and
5984): 12 hours maximum Once course requirements in number 2 above

are met, students may take a maximum of two 4000 level courses. No
courses below the 4000 level will be accepted for graduate credit.
Contact the ME graduate program for approval procedures before taking
any Special (5984 only) or Independent Study (5974 only) courses. In
addition, the doctoral student matriculating with an MS degree must pass
the PhD Qualifying exam within their first 3 semesters as well as passing
a Preliminary Exam/Proposal Defense at least 6 months prior to the
Final Defense. A written Dissertation must be submitted for the Final
Defense. Direct PhD Students may enroll directly from the Bachelors to
the PhD by applying for "Direct-PhD". All PhD requirements are the
same as listed above.

Degree Concentrations:

Biomedical Engineering

Mechanical Engineering graduate students may earn a Biomedical
Engineering Option through the VT-WFU School of Biomedical
Engineering & Sciences while pursuing an advanced degree. Upon
completion of certain requirements the option is placed on the student's
transcript when the degree is conferred. For option requirements please
refer to the SBES web page: www.sbes.vt.edu.

Nuclear Engineering Graduate Certificate

A student must take a total of at least 9 credit hours with a letter grade of
B or better in every course. Six credit hours must be from 5000-level
courses or higher. Required: NSEG 5114 Nuclear Engineering
Fundamentals: 3 credits Electives: Minimum 6 credit hours from the
approved course list (at least 3 credit hours must be at the 5000-level or
higher)

MS Degree

Offered In (National Capital Region, Hampton Roads, Blacksburg)

TOEFL

Paper: (620.0)

iBT: (105.0)

Computer Based: CBT (260.0)

GRE

General: Verbal (450.0), Quantitative (700.0), Analytical (4.5)
German Language
GRE

General: Verbal (150.0), Quantitative (155.0)

Please contact megrad@vt.edu for specific location information.
Acceptance into the VT Mechanical Engineering graduate program is
based on the overall application package. In general, the minimum
target requirements are to the left. The application materials required
can be accessed from the ME application instructions web page. Master
of Science (MS) Degree Requirements The Master of Science (MS) in
Mechanical Engineering requires that masters' students complete a
minimum of 30 semester hours of graduate study beyond the
baccalaureate, and complete a research thesis. MS students must
submit a Plan of Study before completing the first semester registered as
a MS student. The MS in Mechanical Engineering must include the
following minimum requirements: Research and Thesis (5994): 6 hours
minimum (A maximum of 10 hours of 5994 can be used. Students
should register in additional research hours as ME 7994 towards the

PhD and these hours should not appear on the MS plan of study) Approved coursework meeting the following requirements: 20 hours minimum Courses numbered 5000 or higher: 15 hours minimum ME Coursework: 9 hours minimum ME approved Mathematics or Statistics: 3 hours post baccalaureate A maximum of two Virginia Tech 4000 level courses can be used to meet degree requirements. A maximum of 6 hours of Special Study (5984 only), and a maximum of 6 hours of Independent Study (5974 only), with the total of both not to exceed 9 hours is allowed. Transfer courses meeting Graduate School policies, may be listed and approved on the Plan of Study. No courses below the 4000 level will be accepted for graduate credit. International VT-TUD Dual Master of Science Degree The Virginia Tech-Technische Universität Darmstadt (VT-TUD) Dual Master of Science Degree requires that the student complete one year at each university, for a total of 45 semester credit hours of coursework and 15 semester credits of thesis and research. The coursework at TUD is in German and the thesis is written in English. MS degree requirements for both Virginia Tech and the Technische Universität Darmstadt must be completed to receive the diplomas from each university. Refer to the ME Graduate Studies Guide for degree requirements.

Degree Concentrations:

Biomedical Engineering

Mechanical Engineering graduate students may earn a Biomedical Engineering Option through the VT-WFU School of Biomedical Engineering & Sciences while pursuing an advanced degree. Upon completion of certain requirements the option is placed on the student's transcript when the degree is conferred. For option requirements please refer to the SBES web page: www.sbes.vt.edu

Nuclear Engineering Graduate Certificate

A student must take a total of at least 9 credit hours with a letter grade of B or better in every course. Six credit hours must be from 5000-level courses or higher. Required: NSEG 5114 Nuclear Engineering Fundamentals: 3 credits Electives: Minimum 6 credit hours from the approved course list (at least 3 credit hours must be at the 5000-level or higher)

GRADUATE COURSES (ME)

ME 5034:

Bio-Inspired Technology

Introduction to engineering solutions inspired by the functional mechanisms of biological systems. An overview of bio-inspired technology and the state of the art. Exploration of the relationship between engineered and natural biological systems. Concepts of biological systems, such as evolutionary optimization, sensing, actuation, control, system integration, assembly, and materials in engineering terms. State-of-the art of bio-inspired technology. Interdisciplinary analysis skills are practiced in projects where man-made and biological systems are evaluated for parallels and the technological potential of the biological systems. Pre-requisite: Graduate Standing

required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5104:

Thermodynamics: Foundations and Applications

Exposition of the basic concepts and principles of thermodynamics. Principles and results developed for both macroscopic and microscopic systems as well as equilibrium and non-equilibrium states. Definition of entropy for any state. The definition of temperature; pressure, total potential; heat; work; the fundamental Gibbs, Euler, Gibbs-Duhem, and Maxwell relations; characteristic functions; and the state principle. Definition and use of thermo-physical properties, charts, tables, and equations of state for pure as well as mixtures of ideal and real gases, liquids and solids. Second Law analysis, energy conversion, chemical reactions and chemical equilibrium, and introduction to the phenomenological laws of non-equilibrium thermodynamics. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5135 (AOE 5135):

Vehicle Propulsion

Aerothermodynamics of gas turbines and rockets: cycle analysis of turbojets, turboprops, prop fans, and turbo props. Analysis of ramjets and scramjets. Performance of inlets, combustors, and nozzles. Elementary theory of turbomachinery. Liquid and solid propellant chemical rockets. Electrostatic, electromagnetic, and electrothermal propulsion. Integrated rocket-ramjet. Fuels and propulsion systems for future transportation system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3114, ME 3134

Corequisite(s):

ME 5136:

Vehicle Propulsion

turbojets, turbofans, prop fans, and turbo props. Analysis of ramjets and scramjets. Performance of inlets, combustors, and nozzles. Elementary theory of turbomachinery. Liquid and solid propellant chemical rockets. Electrostatic, electromagnetic, and electrothermal propulsion. Integrated rocket-ramjet. Fuels and propulsion systems for future transportation system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3114, ME 3134

Corequisite(s):

ME 5174 (BMES 5174):

Biomechanics of Crash Injury Prevention

Principles of design and analysis of crash injury prevention methods in vehicle crashes. The course encompasses three major focus areas for occupant protection in crashes: crash energy absorption in (1) the vehicle structure, (2) the occupant, and (3) the occupant restraints.

Topics include the biomechanics of impact injury, analysis of occupant response in crash tests, vehicle crash kinematics, modeling of vehicle impact response, modeling of human impact response, and occupant restraint design. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5214:

Combustion

Combustion science and its applications and introduction.

Thermodynamics of gaseous mixtures, chemical kinetics of gases, transport properties of gaseous mixtures, chemical reactors and chemically reacting flows. Waves in chemically reacting flows, deflagrations and deformations. Laminar premixed flames, laminar diffusion flames. Liquid fuels combustion. Pollutants formation in combustion. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3106

Corequisite(s):

ME 5244:

Biofluids

Fluid dynamics of physiological systems with focus on the cardiovascular and the respiratory systems. The course will address: the heart, arterial blood vessels, airways; description of cardiac and pulmonary circulation; anatomy and function of the heart; anatomy and function of the respiratory system; mechanics of soft tissues; review of basic fluid mechanics; continuum mechanics and constitutive modeling; rheology of blood, Newtonian and non-Newtonian; Viscous flow in vessels, Navier-Stokes; mathematical analysis of pulsatile flow; pulse-wave propagation through vessels; particulate flows and particle transport in airways. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5254:

Fuel Cell Systems

Fuel cell systems for transportation, buildings, utility and portable power energy conversion applications. Overview of fuel cell technology. Thermodynamics of direct energy conversion and fuel cell efficiency. Electrochemistry, equilibrium and reaction kinetics. Temperature and pressure effects on polarization curves. Proton exchange membrane fuel cell performance modeling. Fuel cell system components: heat exchangers, humidifiers, air compressors, electric power processing and management. Overall system integration, modeling, and control. Fuel cells for transportation, vehicle performance and efficiency characteristics. Fuel processing and reformers. Fuel cell system design, economics, and optimization. Graduate standing in Engineering required. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5304:

Conduction and Radiation Heat Transfer

Principles of conduction. Analysis of one-dimensional and multidimensional steady and transient, phase change and moving heat source problems are examined. A comprehensive treatment of numerical and analytical methods for solving heat conduction problems is presented.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3304, ME 4304

Corequisite(s):

ME 5314:

Convective Heat and Mass Transfer

Principles of convection. Analysis of heat transfer for internal and external flows; laminar and turbulent boundary layer theories; forced and natural convection. Analysis using similarity transformations, integral solutions and numerical methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5324:

Radiation Heat Transfer

Introduction to thermal radiation; the electromagnetic spectrum; the blackbody; wave phenomena versus geometric optics; polarization, diffraction, and refraction effects; emission, reflection, absorption, and transmission of thermal radiation by surfaces; radiant interchange among surfaces; radiation through a participating medium; the Monte Carlo raytrace method; uncertainty and confidence interval of results.

Knowledge of thermodynamics at the undergraduate level is recommended.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5404:

Fluid Dynamics

Fundamental fluid mechanics: kinematics and dynamics. Continuum fluid dynamics including hydrostatics, flow kinematics, the concept of stress, constitutive relations, the equations of motion and energy for compressible and incompressible viscous and inviscid flows.

Incompressible Newtonian viscous flows, similitude and physical modeling, inviscid potential flows, inviscid flows with vorticity, boundary layers, and an introduction to turbulent flow. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3404

Corequisite(s):

ME 5424:

Turbomachinery

Application of fluid mechanics and thermodynamics to turbomachinery, with emphasis on high speed machines. Review of basic concepts and ideal performance. Viscous effects - losses and stall. Three dimensional and secondary flow. Actual machine performance and design considerations. Selected topics including axial and centrifugal machines, transonic flow, transient behavior, and three-dimensional flow design. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 4414

Corequisite(s):

ME 5434:

Advanced 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. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ME 5504:

Introduction to Rotor Dynamics Analysis

Theory and application of dynamics, vibrations, fluid mechanics, and tribology to the design of rotating machinery. Course content covers material from single mass rotor analysis up to multi-mass rotor system analysis. System critical speeds, forced response, and dynamic stability are discussed. Hydrodynamic bearings, liquid seals, and gas labyrinth seals are presented as necessary elements for rotor design analysis.

Field balancing by single plane, two plane and multi plane methods are presented. Experimental in-class work on single and two- plane methods. Industry standards are discussed. State of the art PC

optimum rotor design analysis. One computer analysis program will be written by the student in a language or math package of their choice. A formal presentation of a course project will be given at the end of semester by each student enrolled for credit. Even Years. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3504, ME 4404

Corequisite(s):

ME 5506:

Advanced Control Engineering

Unification of the analysis and design techniques of a broad range of dynamic systems through the use of the tools of modern control. Builds upon the background of classical control topics including Nyquist, Bode, and root locus. Emphasis upon developing the tools of state-space control theory and applying these tools to effect the design of controllers for linear dynamic systems. 5506: Transform analysis and design of systems with digital and continuous components. Classical and modern treatments along with discussion of quantization effects. Design problems with hands-on experience.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 4504

Corequisite(s):

ME 5514:

Vibrations of Mechanical Systems

Single degree-of-freedom systems, multiple-degree-of-freedom system and distributed parameter systems ending in dynamic finite element modeling. Numerical solutions, isolation, absorption, optimal design for vibration reduction, analytical modal methods, transfer function methods. Damping models and analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3504

Corequisite(s):

ME 5524:

Bayesian Robotics

Principles of autonomous robotics control for unstructured environments. Probability theory, numerical techniques for recursive Bayesian

estimation and multi-sensor data fusion, simultaneous localization and mapping, quantification of belief, Bayesian control. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5544 (AOE 5744) (ECE 5744):

Linear Systems Theory

Advanced introduction to the theory of time-varying and time-invariant linear systems represented by state equations; solutions of linear systems, uniform stability and other stability criteria, uniform observability and controllability, state feedback and observers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR

ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR

ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

ME 5554 (ECE 5754) (AOE 5754):

Applied Linear Systems

Develop an applied understanding of state-space representations for linear time invariant multi-input multi-output dynamic systems in both time domain and frequency domain. Introduction to modern state-space control methods; state feedback and output feedback. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 OR ECE 4624 OR ECE 4634 OR ME 4504

OR AOE 4004 OR ECE 4405 (UG) OR ECE 4624 (UG) OR ECE 4634

(UG) OR ME 4504 (UG) OR AOE 4004 (UG)

Corequisite(s):

ME 5564 (AOE 5764) (ECE 5764):

Applied Linear Control

Analysis and design of sampled-data systems, extraction of discrete-time dynamic models from experimental data, and implementation of dynamic compensators on digital processors. In-depth design

filtering. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5554 OR ME 5544 OR AOE 5744 OR AOE 5754
OR ECE 5744 OR ECE 5754

Corequisite(s):

ME 5574 (ECE 5774) (AOE 5774):

Nonlinear Systems Theory

Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations: existence and uniqueness of solutions; continuous dependence on parameters; stability of equilibria and stability analysis techniques; input-to-state stability; input-output stability; nonlinear design techniques including input-state and input-output feedback linearization, backstepping, and sliding mode control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

ME 5584 (AOE 5734) (ECE 5734):

Convex Optimization

Recognizing and solving convex optimization problems. Convex sets, functions and optimization problems. Least-squares, linear, and quadratic optimization. Geometric and semidefinite programming. Vector optimization. Duality theory. Convex relaxations. Approximation, fitting, and statistical estimation. Geometric problems. Control and trajectory planning. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5634:

Finite Elements in Machine Design

Advanced analysis and design of machine components with emphasis on the finite element method of analysis using commercial software.

Structural and continuum elements will be used for both the static and

dynamic analysis and design of machine components. Practice oriented analysis techniques and design procedures employable through the finite element method will be developed. Design problems will constitute a significant part of the course. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3614

Corequisite(s):

ME 5644:

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. Partially duplicates ME 4644; credit may only be received for one course. Co: ME 4634 or equivalent background; programming skills.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5654:

Modeling and Simulation of Multibody Dynamic Systems

Develops basic mathematical tools for kinematics and dynamics modeling of planar and spatial rigid multibody dynamic systems. Introduces absolute and relative kinematic constraints and driving constraints. Introduces the virtual work and the generalized force concepts. Derives the equations of motion for constrained rigid multibody systems. Studies the inverse dynamics of kinematically driven systems, equilibrium conditions, and constant reaction forces. Introduces Euler parameters for the orientation of rigid bodies in space. Presents numerical considerations in solving spatial differential-algebraic equations of motion. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5664:**Global Collaborative Product Development**

Participants will study topics fundamental to global collaborative product development, project 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 4664; credit may only be received for one course. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ME 2024 (UG) OR ME 2024), (ME 4634 (UG) OR ME 4634)

Corequisite(s):

ME 5674:**Tire Mechanics**

Introduction to tire mechanics with emphasis on tire modeling for vehicle dynamic simulation. Tire mechanics explained from several view points: engineering mechanics, system dynamics, and empirical procedures.

Vehicle dynamic modeling including suspension and steering systems covered providing details on the effect of tire dynamics on vehicle behavior. Real tire data provided to be used for vehicle dynamics simulation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5694:**Advanced Design Project**

Teams solve complex engineering problems, typically originating for industry, with emphasis on new product development, using the engineering design process. Emphasis on project management, engineering economics, and professional skills in presentation of a proposed business plan and technical solution. Intended for students in the Virginia Tech - Technische Universität Darmstadt dual Master of Science in Mechanical Engineering degree program. May be repeated for a maximum of 6 credits, but then in different fields of mechanical engineering. Variable credit of 1-6 hours

Credit Hour(s): 1 TO 6

Lecture Hour(s): 1 TO 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ISE 5174

Corequisite(s):

ME 5714 (BMES 5514):**Digital Signal Processing for Mechanical Measurements**

The fundamentals of digital signal processing of data experimentally obtained from mechanical systems will be covered. Attention will be given to the data acquisition, A/D conversion, aliasing, anti-aliasing filtering, sampling rates, valid frequency ranges, windowing functions, leakage, and various transform methods. Special attention will be given to random, transient, and harmonic function data processing. Various methods of estimation of the frequency response function (FRF) will be explored. The estimation methods will be assessed as to their impact on FRF estimation errors. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3504, ME 4504

Corequisite(s):

ME 5724:**Advanced Instrumentation and Signal Processing**

Advanced techniques in instrumentation using state-of-the-art transducers, techniques in data acquisition and signal processing. Techniques for estimating errors and optimizing data quality.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 4005

Corequisite(s):

ME 5734:**Advanced Engineering Acoustics**

The fundamental principles underlying the generation, transmission, and reception of acoustic waves will be presented. Methods for analytically investigating various acoustic and structural acoustic situations encountered in practice will be developed. The application of these methods to typical engineering acoustical problems with physical interpretation of the results will be demonstrated.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

419 Prerequisite(s): ME 4724

Corequisite(s):

ME 5735G:

Advanced Mechatronics

Electromechanical design and control 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5736G:

Advanced Mechatronics

Electromechanical design and control 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.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5735G

Corequisite(s):

ME 5744:

Methods of Mechanical Engineering Analysis

Introduction to selected mathematical techniques oriented toward solving advanced continuous and lumped parameter problems of the type often encountered in mechanical engineering. Elliptic, parabolic and hyperbolic ordinary and partial differential equations are discussed. Solution by separation of variables, integral transforms, Green's functions and numerical methods. The emphasis is on understanding how physical processes work.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5754 (BMES 5164):

Advanced Impact Biomechanics

A review of impact biomechanics and critical investigation of the impact response of the human body. Participants will study the dynamic response of the head, neck, chest, abdomen, upper extremities and lower extremities. Real world examples from automobile safety, military applications, and sport biomechanics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3504, ME 3614 OR ESM 3054, ESM 3124

Corequisite(s):

ME 5764:

Modeling MEMS and NEMS

Modeling MEMS and NEMS is about the construction, analysis, and interpretation of mathematical and computational models of microelectromechanical and nanoelectromechanical systems (MEMS and NEMS). A goal throughout the course will be to develop a physical intuition for the fundamental phenomena at these small scales. The material covered will be broad and multidisciplinary including: dimensional analysis and scaling; a review of continuum mechanics; fluid dynamics, elasticity, thermal transport, and electromagnetism at the micro and nanoscales; the modeling of a variety of new MEMS/NEMS devices; and approaches beyond the continuum theory including stochastic and deterministic methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5774:

Introduction to Stochastics

Provide a strong foundation for analyzing stochastic processes and exposure to state-of-the-art techniques. Strengthen existing knowledge of probability and statistics including covariance functions and properties, stationarity and ergodicity, and spectral density. Introduce stochastic processes and modeling and analysis techniques including Markov Chains, and ARIMA models. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ME 5804:**Active Material Systems and Smart Structures - I**

Behavior and physics associated with ceramic and polymeric active materials; constitutive models of piezoelectric and electrostrictive ceramics and polymers derived from thermodynamic relationships; development of static and dynamic models of systems that incorporate active materials derived using variational mechanics. Piezoelectric and electrostrictive ceramics and polymers, ionomeric polymers, conductive polymers, and carbon nanotubes will be studied. Applied topics in structural health monitoring, motion control, vibration control, and sensing will be studied.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3514, ME 3504 OR ME 4504

Corequisite(s):

ME 5814:**Energy Harvesting**

Criterion of harvesting, identification of energy sources, theory of vibrations, PSD, measurement and analysis. Selection of materials for energy conversion, piezoelectric, electromagnetic, electrostrictive, magnetostrictive, magnetoelectric, dielectric elastomers, conducting polymers, metal-ceramic composites, electrets, electrostatic, thermoelectric, photovoltaic. Design and characterization, modeling and fabrication of vibration, wind, thermal gradient, and light energy harvesters; resonance phenomenon, equivalent circuits and storage.

Case studies for applications of industrial systems, surveillance, automobiles and the human body. Pre-requisite: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5864G:**Advanced 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-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5904:**Project and Report**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ME 5914:**Autonomous Systems Seminar**

Weekly technical presentations from local and visiting scholars on current topics related to the theory, design and development, and application of autonomous vehicle systems. Pre-requisite: Graduate standing required

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5944:**ME Graduate Seminar**

This course will consist of a series of 50-minute lectures given by invited guests from industry, government organizations, and other universities as well as ME Ph.D students. May be repeated for a maximum of 6 credits. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ME 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ME 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ME 6104:**Advanced Topics in Thermodynamics**

Exposition of the basic concepts and principles of statistical thermodynamics including statistical mechanics, probability theory, quantum mechanics, kinetic theory, and thermo-physical and transport properties. Presentation of the basic concepts and principles of gas dynamics for compressible flow within normal temperature ranges (i.e. excluding the very high temperatures at which plasmas form). A more in depth look at chemical thermodynamics including chemical equilibrium and chemical kinetics. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5104

Corequisite(s):

ME 6404:**Turbulence and Turbulent Flow**

Nature and origin of turbulence, turbulent transport of momentum and heat, dynamics of turbulence, theoretical and statistical approaches, closure schemes. Analysis of turbulent flows including grid-generated turbulence, free shear flows, and wall-bounded flows. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5404

Corequisite(s):

ME 6405:**Advanced Internal Flow**

Conservation equations and constitutive relations, exact Navier Stokes solutions; boundary layer approximation and special solutions; approximate methods; compressibility and heat and mass transfer effects; numerical methods, turbulence models. 6406: selected topics on recent activities in the fluid dynamics research community, including theory, analysis, and computational modeling. Specific topics will vary depending upon the instructor's areas of expertise.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ME 5404

Corequisite(s):

ME 6434 (AOE 6434):**Computational Fluid Dynamics and Heat Transfer**

Overview of numerical methods used in the study of computational fluid dynamics (CFD) and heat transfer. Spatio-temporal finite-difference, finite-volume discretizations, solution of linear systems with direct and iterative methods, algorithms for solving the Navier Stokes and energy equations, and turbulence modeling. Applications to inviscid subsonic, transonic, and supersonic flows and viscous boundary layer. Theory reinforced with hands on programming assignments and the application of commercial CFD packages to select problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5404, ME 5314, (AOE 3114 (UG) OR AOE 3114), (ME 4404 (UG) OR ME 4404), ME 5104

Corequisite(s):

Verification and Validation in Scientific Computing

Applicable to scientific and engineering models described by partial differential or integral equations. Software engineering, code verification, and the method of manufactured solutions for generating exact solutions. Estimation of numerical approximation errors in scientific computing. Design and execution of experiments for model validation and model accuracy assessment. Propagation of aleatory and epistemic uncertainty through models. Estimation of total prediction uncertainty in scientific computing simulations. Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ME 6504:

Topics in Advanced Control Applications

Timely subjects in applications of control theory. Topics to be chosen from include optimization, adaptive control, learning control, and non-linear analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ME 6544 (AOE 6744) (ECE 6744):

Linear Control Theory

Advanced introduction to the theory of optimal control of time-varying and time-invariant linear systems; Solutions to the linear-quadratic regulator, optimal filtering, and linear-quadratic-gaussian problems; Robustness analysis and techniques to enhance robustness of controllers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5544 OR ME 5554 OR AOE 5744 OR AOE 5754

Corequisite(s):

ME 6574 (ECE 6774) (AOE 6774):

Adaptive Control Systems

Introduction to the theory and methodology used to design adaptive controllers for uncertain systems, addressing issue such as input

constraints, disturbance rejection, partial measurements, and robustness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 5774, ECE 5744) OR (ME 5544, ME 5574) OR (AOE 5774, AOE 5744)

Corequisite(s):

ME 6624:

Adv Fin Elem Applic

Advanced application of the finite element method to mechanical design problems. Nonlinear analysis techniques: geometric nonlinearity, material behavior elastic and inelastic response, moving boundary conditions, multi-component contact problems. Dynamic response analysis; direct integration, mode superposition. A semester finite element analysis/design project is a significant part of the course. Must have prerequisite or an equivalent linear finite element background.

Taught alternate years. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5634

Corequisite(s):

ME 6704:

Acoustic-Structural Interaction

The fundamental principles underlying the coupled vibration of structures and their radiated sound field will be outlined. Methods for analytically investigating the motion of elastic structures surrounded by acoustic mediums will be studied. Beam, plate, and cylindrical shell structures will be considered. Application of the methods developed to various situations encountered in practice and research will be studied. An introduction to the boundary element method will be presented. I,II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5734

Corequisite(s):

ME 6744:

Chaos & Nonlinear Dynamics

Overview of theoretical and numerical approaches for the study of

bifurcation analysis, predictability, strange attractors, and routes to chaos. Roles of dissipation and noise in deterministic chaos. Use of Lyapunov spectra, fractal dimension, information, entropy, correlation functions, and attractor reconstruction to describe chaos. Chaos in iterated maps and systems of nonlinear ordinary differential equations. Spatiotemporal chaos in coupled map-lattices and in systems of nonlinear partial differential equations. Numerical integration of systems of stiff equations, operator splitting, exponential time integration, spectral and pseudo-spectral methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5404, ME 5744

Corequisite(s):

ME 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ME 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MINING ENGINEERING

Gregory Adel, Head

Professors: Gregory Adel; Michael Karmis; Gerald Luttrell; Erik Westman; Roe Yoon;

Associate Professors: Mario Karfakis; Kramer Luxbacher;

Assistant Professors: Nino Ripepi; Emily Sarver;

E. Morgan Massey Professor: Gerald Luttrell;

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Student Handbook:

[http://www.mining.vt.edu/academics/MinE%20Graduate%20Manual%20\(Fall%202011\).pdf](http://www.mining.vt.edu/academics/MinE%20Graduate%20Manual%20(Fall%202011).pdf)

Department Website: <http://www.mining.vt.edu/>

The Department of Mining and Minerals Engineering (MinE) offers advanced graduate degrees (MEng, MS and PhD) that are designed to educate students for high-level challenges in research and development. The degrees prepare graduates for successful careers in industry, academia, and government. Graduate research may be pursued in several areas of specialization including rock mechanics, ground control, equipment evaluation, systems analysis, health and safety, mineral and coal processing, applied surface and colloid chemistry, conservation and the environment, mining ventilation, mine electrical systems, computer applications, and mineral economics. One or more of the topics may be emphasized within the department at a given time based on the ongoing research activity of the eight full-time research faculty members assigned to the department. Graduate students accepted to the program are generally provided financial support through sponsored grants, teaching assistantships or graduate fellowships. The graduate program also recognizes the specific needs of industry professionals with a program that strives to (i) upgrade technological skills of practicing engineers, (ii) encourage the pursuit of doctoral-level work, and (iii) provide an opportunity for advanced education and career reorientation. A major goal of the department is to afford all graduate students with the opportunity to participate in creative and challenging research projects, which typically lead to scholarly publications in international journals and conference proceedings.

SPECIAL FACILITIES

The Department of Mining and Minerals Engineering at Virginia Tech offers graduate students access to state-of-the-art equipment and world-class facilities for research studies. The facilities include laboratories for rock mechanics, mine ventilation, health and safety, advanced earth systems instrumentation, mine automation and control, mineral processing and applied surface and colloid chemistry. The laboratories are supported by a well-equipped mechanical shop managed by skilled technicians. The following is a listing of laboratories currently operated and maintained by the department.

Department Facilities

The following is a listing of laboratories currently operated and maintained by the department. Rock Mechanics Laboratory: The rock mechanics facilities include a laboratory for preparation of rock specimens for strength testing, three megapound testing machines (three MTS servo-controlled, stiff-test units with computerized data acquisition facilities, one of which is for dynamic testing at 2 m/sec loading rate), triaxial and two shear testing units, a creep testing machine with digital data acquisition system, equipment for seismic testing of rock in both field and laboratory, and subsidence monitoring equipment. Mine Ventilation Laboratory: The facilities in the mine ventilation laboratory include three scaled wind tunnels, fans and various

equipment for ventilation air monitoring including analog and digital manometers, methane detectors and anemometers. An additional tunnel is fully instrumented with fan control by PLC and injection and sampling ports for tracer gas experiments. The laboratory is also equipped with a high performance computer for CFD simulations using Fluent software. Two gas chromatographs are also housed in the laboratory capable of detection by electron capture detector (ECD), thermal conductivity detector (TCD) and flame ionization (FID) for analysis of tracer and mine gases.

Health and Safety Laboratory: The facilities in the health and safety laboratory include capability for gas/dust analysis and noise monitoring.

Earth Systems Instrumentation Laboratory: The facilities in the Earth Systems Instrumentation Laboratory include a 16-source, 18-receiver ultrasonic tomography system. This system includes a Panametrics ultrasonic pulser, a 16-channel switchbox, PAC Micro-80 piezoelectric transducers, and National Instruments PXI-6115 high-speed digitizers (20 Msamples/sec). Additional equipment includes a 16-channel acoustic emission monitoring system which is used for laboratory passive tomography.

Mine Automation and Process Control Laboratory: The facilities in the Mine Automation and Process Control Laboratory include 10 workstations equipped with state-of-the-art industrial programmable logical controllers (PLCs) and associated input/output and communication modules. The workstations provide hands-on experience in hardware configuration, software development, input/output wiring, ladder logic programming, analog-digital conversion, loop control and tuning, communication architectures, human interfaces and troubleshooting.

Mineral Processing Laboratories: The facilities in mineral processing include various types of crushing and grinding equipment; complete pilot-plant with a ball mill, flotation banks, flotation columns, a thickener, a filter and ore bins, conveyors, belts, and pumps. Equipment for particle characterization includes a vast array of analytical instruments for particle size and mineralogical/elemental analysis. In addition, an entire suite of coal analysis equipment is available for determining proximate analysis, sulfur, Btu and ash fusion temperature.

Surface and Colloid Chemistry Laboratories: Some of the noteworthy facilities of the surface and colloid chemistry laboratories include a UV spectrophotometer, AA spectrometer, FTIR spectrophotometer, isothermal/isoperibol microcalorimeter, flow microcalorimeter, potentiostats, turbidimeter, surface tensiometers, electrophoresis apparatus, ellipsometers, surface force analyzer, atomic force microscope, and Langmuir trough.

Advanced Computing Laboratory: In addition to the university's state-of-the-art supercomputer systems, the department operates a dedicated computing facility equipped with modern workstations and large-scale printers/plotters.

Research Centers

The Department of Mining and Minerals Engineering is home to two acclaimed research centers, i.e., Virginia Center for Coal and Energy Research (VCCER) and the Center for Advanced Separation

Technologies (CAST). The centers offer students access to cutting-edge facilities and equipment in these specific focus areas.

Center for Advanced Separation Technologies (CAST) - CAST is a consortium of five universities whose goal is to develop advanced technologies that can be used to produce clean solid, liquid and gaseous fuels from domestic energy resources in an efficient and environmentally acceptable manner. Current member institutions are Virginia Tech, West Virginia University, University of Kentucky, University of Utah and Montana Tech. CAST has funded more than 100 projects at seven universities. More information about this center can be obtained at www.cast.mining.vt.edu.

Virginia Center for Coal and Energy Research (VCCER) - VCCER serves as an interdisciplinary study, research, information and resource facility for the Commonwealth of Virginia. VCCER involves five primary functions: (i) Research in interdisciplinary energy and coal-related issues of interest to the Commonwealth, (ii) Coordination of coal and energy research at Virginia Tech, (iii) Dissemination of coal and energy research information and data to users in the Commonwealth, (iv) examination of socio-economic implications related to energy and coal development and associated environmental impacts, and (v) assist Commonwealth of Virginia in implementing the Commonwealth's energy plan. The center has offices in the main Virginia Tech campus in Blacksburg, the National Capital Region Office in Alexandria, and the Southwest Virginia Higher Education Center in Abingdon. More information about this center can be obtained at www.energy.vt.edu.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Master of Science (MS): Successful MS students must complete 30 hours of university credit of which a minimum of 20 hours involve coursework and a maximum of 10 hours involve research. Students must also prepare and defend a written Thesis of their research findings during a Final Examination before an Examining Committee.

MEng Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Master of Engineering (MEng): Successful MEng students must complete 30 hours of applicable coursework and prepare and defend a written Project Report during a Final Examination before an Examining Committee.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Doctor of Philosophy (PhD): Successful PhD students must complete 90 hours of university credit of which a minimum of 30 hours involve coursework and a maximum of 60 hours involve research. Students must also prepare and defend a written Dissertation of their research findings during a Final Examination before an Examining Committee. PhD candidates must also pass a Preliminary Examination at least six months prior to taking the Final Examination.

GRADUATE COURSES (MINE)

MINE 5015:

Advanced Mining Engineering

Selected concepts and principles in the discipline including factors in pillar design, contiguous bed mining, and technical problems in deep mining; mineral beneficiation, coal technology, hydrometallurgical, and pyrometallurgical processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): 4L, Lecture

Instruction Type(s): 4L, Lecture

Prerequisite(s): , MINE 4074

Corequisite(s):

MINE 5016:

Advanced Mining Engineering

Selected concepts and principles in the discipline including factors in pillar design, contiguous bed mining, and technical problems in deep mining; mineral beneficiation, coal technology, hydrometallurgical, and pyrometallurgical processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): , MINE 4074

Corequisite(s):

MINE 5025:

Advanced Mining Design

Selected advanced design problems in mining including roof control, shafts, material handling, transportation, drainage, and ventilation.

Advanced work in creative quantitative design or ore milling and coal preparation plants.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5026:

Advanced Mining Design

Selected advanced design problems in mining including roof control, shafts, material handling, transportation, drainage, and ventilation.

Advanced work in creative quantitative design or ore milling and coal preparation plants.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5045:

Advanced Mineral Processing

The theory of reactions in flotation systems and application of physical chemistry to mineral beneficiation. Advanced studies in electrostatic and magnetic separation. Theory and application of differential gravity separations. Advanced studies in comminution, grinding systems, and coal preparation plant design, simulation, and control. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5046:

Advanced Mineral Processing

The theory of reactions in flotation systems and application of physical chemistry to mineral beneficiation. Advanced studies in electrostatic and magnetic separation. Theory and application of differential gravity separations. Advanced studies in comminution, grinding systems, and

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5054:

Computer Applications and Modeling of Mining Operations

Applications of computer programs to the modeling and estimation of ore reserves, the scheduling and planning of mine activities, the optimization of mine production, and the design and selection of equipment and support systems. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5084:

Stability of Rock Slopes

Factors affecting the stability and stabilization of rock slopes, geological site studies, mechanical properties of joints, calculations, influence of ground water, geometry, seismic effects, and case histories.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): , GEOS 4414

Corequisite(s):

MINE 5085:

In Situ Rock Measurements and Monitoring

In situ testing of rocks rationale, in situ rock mass behavior, initial state of stress, stress-strain in polar coordinates, hole in a plate problem, internally pressurized thick walled cylinder problem, in situ rock stress measurement methods, insitu performance monitoring of rock structures, and field instrumentation. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5094:

Particulate Process Modeling

Statistical and mechanistic approaches to modeling of mineral processing and other particulate systems. Population balance modeling of particulate systems. Representation of particle distributions. Numerical simulation techniques using the digital computer. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5104:

Modeling and Monitoring the Behavior of Mining Systems

Advanced numerical modeling and monitoring methods. Emphasis on the use of numerical tools and monitoring methods in understanding the complex behavior of mining systems. Application of these tools to areas such as mineral processing, underground and surface structures, and material flow through independent project work. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5205:

Coalbed Methane Reservoir Engineering

Reservoir engineering specific to coal beds for extraction of methane, including theory of gas flow in porous media, geomechanical effects of reservoir depressurization, reservoir simulation and production forecasting, drilling methods and patterns, and interactions with underground mine workings. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

427 Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MINE 5944:

Seminar

Two written or oral presentations to be made by all graduate students on their thesis topics; also participation in all other graduate student, visiting lecturer, and faculty member presentations during their scholastic tenure. Required of all students for graduation. All graduate students in the department are required to enroll in the seminar for two semesters and to attend all the seminars.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

MINE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

MINE 6034:

Chemistry of Flotation

Surface and colloid chemistry as applied to the technology of froth flotation; surface energetics, thermodynamics of adsorption, electrification of interfaces, chemistry of surfactants, oxidation and reduction of sulfide minerals, electrochemistry of sulfide flotation systems, and hydrodynamics of bubble-particle adhesion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

MINE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

OCEAN ENGINEERING

Eric Paterson, Head

Professors: Alan Brown; Robert Canfield; William Devenport; Rakesh Kapania; Eric Paterson; Pradeep Raj; Christopher Roy; Joseph Schetz; Robert Walters; Craig Woolsey;

Associate Professors: Jonathan Black; Mazen Farhood; Lin Ma; Leigh McCue-Weil; Wayne Neu; Mayuresh Patil; Michael Philen; Cornel Sultan;

Assistant Professors: Colin Adams; Seongim Choi; Kevin Lowe; Gary Seidel; Bhuvana Srinivasan; Kevin Wang; Heng Xiao;

NAVSEA Professor of Naval Ship Design: Alan Brown;

Norris and Laura Mitchell Professor of Aerospace Engineering: Rakesh Kapania;

Rolls-Royce Commonwealth Professor of Marine Propulsion: Eric Paterson;

Fred D. Durham Endowed Chair Professor: Joseph Schetz;

Graduate Contact: aoegradcoordinator@vt.edu

Student Handbook: http://www.aoe.vt.edu/graduate/forms/AOE_Graduate_PP_Fall-2011.pdf

Graduate Site: <http://www.aoe.vt.edu/graduate/index.html>

Master of Science Degree The Department of Aerospace and Ocean Engineering offers a Master of Science Degree in Aerospace Engineering and in Ocean Engineering. Each of these degrees has two

options, a Master of Science with or without thesis. Although both degrees require the same number of credit hours for graduation, the thesis option requires some of these credits be devoted to a research project. The non-thesis option can be obtained by taking only course work, or it can include credits for a project and report. Such a project and report is generally not research oriented, but deals with other aspects of an engineering problem and may involve a team of students. In order to ensure that all our students can communicate with scientists and engineers outside their primary field of interest, all students take at least one course in the general areas of aerodynamics, structures, flight mechanics and control, and numerical methods. In addition, students in the non-thesis program are required to take additional courses in their area of study. Students in this program have the opportunity to work on advanced research projects in the three areas mentioned previously as well as in the interdisciplinary arena where familiarity with two or more disciplines is required. As a result many of our students are in a position to satisfy the rapidly growing demand for well rounded engineers and scientists. In addition, the Aerospace and Ocean Engineering Department participates in the Systems Engineering interdisciplinary program where students take courses across several engineering departments and outside of the College of Engineering. The requirements for this program are set by the Systems Engineering Advisory Committee and are different from those indicated previously. Students following the thesis route work with faculty that have both national and international reputations in their respective areas of research. These areas pose exciting new challenges to the students who have the opportunity to work closely with their faculty advisor on current problems. These problems reflect the latest interests in new advancements in science and technology by NASA, Navy, Air Force, and various aerospace and non-aerospace industries. Our masters students do significant hands-on research and often work in teams with other masters and Ph.D. students on wide-range of topics, some focused in a newly developing area, and some multidisciplinary in nature. These activities include state-of-the art research in aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Students are encouraged to present their research results at conferences and in archival journals tied to industry and/or government or sponsored projects and include interaction with personnel and facilities from those organizations. The requirements for the degrees focused on applied physics or applied mathematics are slightly different from those of the other categories in that some required courses from the Aerospace and Ocean Engineering Department are replaced with others from either Physics or Mathematics respectively. These programs are specially tailored for students whose backgrounds are from outside the engineering environment and are interested in applying their skills to solving aerospace problems. Such programs encourage interaction with disciplines outside the usual engineering environment and result in new approaches to analyzing and solving problems. Doctor of Philosophy Degree The Aerospace and Ocean Engineering Department offers a Doctor of Philosophy Degree in Aerospace Engineering. This degree is a research oriented degree which can be focused toward one (or more) of several disciplines. These disciplines include aerodynamics, structures and structural dynamics, flight dynamics and control, ocean engineering, multidisciplinary design, applied mathematics, and applied physics. All of these degrees require an in depth research project which will serve as the subject of the final dissertation. Research projects have been carried out in the areas of computational fluid dynamics (CFD), experimental fluid mechanics (both high and low speed), instrumentation development, composite materials, structural optimization, flutter analysis, nonlinear flight control, pilot-aircraft interactions, aerodynamic modeling, computer aided design, interdisciplinary design and optimization, trajectory analysis and optimization, space mechanics and space vehicle design, to name a few.

Many of these programs are tied to industry and/or government sponsored projects and include interaction with personnel and facilities from those organizations. The requirements for the degrees focused on applied physics or applied mathematics are slightly different from those of the other categories in that some required courses from the Aerospace and Ocean Engineering Department are replaced with others from either Physics or Mathematics respectively. These programs are specially tailored for students whose backgrounds are from outside the engineering environment and are interested in applying their skills to solving aerospace problems. Such programs encourage interaction with disciplines outside the usual engineering environment and result in new approaches to analyzing and solving problems. Students in the PhD program work with faculty members known nationally and internationally for their contributions in their research area. Opportunities exist to work on the very latest research projects in the areas of aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Many of these projects are in support of aerospace and non-aerospace industry, NASA, Navy and Air Force initiatives and include both analytical and experimental components. Modern computational and experimental facilities are available to each student including four subsonic wind tunnels and one supersonic wind tunnel. Advanced instrumentation is available for taking measurements of all type in these facilities.

SPECIAL FACILITIES

Research in Aerospace and Ocean Engineering poses exciting new challenges to the students who have the opportunity to work closely with their faculty advisor on current problems. These problems reflect the latest interests in new advancements in science and technology by NASA, Navy, Air Force, and various aerospace and non-aerospace industries. Our graduate students do significant hands-on research and often work in teams with other graduate students on wide-range of topics, some focused in a newly developing area, and some multidisciplinary in nature. These activities include state-of-the art research in aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Students are encouraged to present their research results at conferences and in archival journals tied to industry and/or government sponsored projects and include interaction with personnel and facilities from those organizations. Research in Aerospace and Ocean Engineering poses exciting new challenges to the students who have the opportunity to work closely with their faculty advisor on current problems. These problems reflect the latest interests in new advancements in science and technology by NASA, Navy, Air Force, and various aerospace and non-aerospace industries. Our graduate students do significant hands-on research and often work in teams with other graduate students on wide-range of topics, some focused in a newly developing area, and some multidisciplinary in nature. These activities include state-of-the art research in aerodynamics, structures, flight dynamics and control, and multidisciplinary analysis and design. Students are encouraged to present their research results at conferences and in archival journals tied to industry and/or government sponsored projects and include interaction with personnel and facilities from those organizations.

Ship Dynamics Lab

The VT AOE Ship Dynamics Laboratory provides space for cutting edge analytical, computational, and experimental research into vessel stability, capsize, and quiescence. Amongst other resources, the laboratory is home to two dual-processor high performance Linux workstations to enable computationally efficient simulation of seakeeping and strongly

nonlinear capsizes behavior over large parameter ranges.

Towing Basin

Modeling ship resistance is done by towing a model in a towing basin. The basin, located in the basement of Norris Hall is made of reinforced concrete painted with a chemical and moisture resistant enamel. The width of the basin is 6 feet and the maximum water depth is 4 feet. The overall length of the basin is 98 feet but the first 4 feet and the last 24 feet are used for braking the carriage. The usable test length is then approximately 70 feet. There are two glass walled observation pits along the side of the tank, one located approximately in the middle of the test region and the other pit located at the starting end. The observation pit at the starting end is intended for use in the study of wave reflection and absorption. The carriage and rails were designed and constructed by the firm of Kempf and Remmers of Hamburg, Germany and were shipped in sub-assemblies to Virginia Tech. The allowable tolerance on rail height was 0.1mm. Wedges were used to give final straight alignment of each rail. The allowable tolerance on alignment was 0.2mm. Final alignment was done optically. After final adjustments in height were made, the space between the bearing plates and the bottom of the rail was filled with concrete. A 400 V DC motor drives the carriage through a gear reduction box. The DC power is supplied from a 220 V AC motor-generator set. A maximum speed of the carriage of 3.0 meters per second can be obtained. The carriage braking is done automatically using trips installed at both ends. An emergency brake button is also on the console. The brake is of the magnetic clutch type and brakes the DC motor directly. The brake is applied if power to the carriage is interrupted. Braking deceleration is 0.7 meter per second per second. Ocean Engineering undergraduate students perform two experiments in the basin. They test the resistance of both a surface ship and a submarine.

DEGREES OFFERED

MS Degree

Offered In (Virtual, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal, Quantitative, Analytical

Master of Science Requirements: Thesis and (Non-Thesis) 1. A minimum of 30 credit hours is required. For thesis students, up to 10 credit hours may be allotted for Research and Thesis (AOE 5994). For non-thesis students, up to 6 credit hours may be allotted for Project and Report (AOE 5904)[1]. 2. A minimum of 12 credit hours (15 for non-thesis) of graded course work numbered 5000 and higher must be included in the Plan of Study. These credit hours do not include the AOE

Seminar (AOE 5944), Research and Thesis (AOE 5994) hours, or Project and Report (AOE 5904) hours. 3. A maximum of 6 credit hours (9 for non-thesis) of 5974 and 5984 is allowed. 4. A maximum of 6 credit hours of approved 4000 level course work is allowed. 5. Up to 50% of the courses on the Plan of Study may be transferred from a graduate program at another institution, subject to the approval of the Advisory Committee. Each transferred course must have a grade of B (3.0/4.0) or better. 6. All Ocean Engineering M.S. candidates are required to take: AOE 5104, Advanced Aero and Hydrodynamics; AOE 5334, Advanced Ship Dynamics; AOE 4404, Applied Numerical Methods; and AOE 5074, Advanced Ship Structural Analysis[3]. In addition, thesis (non-thesis) students must take 9 (18) hours of approved electives, and non-thesis students must take 6 units of "Project and Report" or complete a 6 unit Capstone Naval Ship Design Project (AOE 5315 and AOE 5316). Electives for thesis students are determined in consultation with the Advisory Committee Chair. Non-thesis ocean engineering students must take two of the following seven courses: AOE 5034, Mechanical and Structural Vibrations; AOE 5044, Dynamic Stability of Structures; AOE 5374, Rationally-Based Design of Ocean Structures; AOE 5144, Boundary Layer Theory and Heat Transfer; AOE 5454, Advanced Aerospace and Ocean Engineering Instrumentation; AOE 4024, An Introduction to the Finite Element Method; AOE 4344, Dynamics of High Speed Marine Craft; AOE 4264, Principles of Naval Engineering; AOE 5314, Naval Ship System Design[4]; and AOE 5434, Introduction to Computational Fluid Dynamics. 7. If a student has previously taken any of the required courses listed above or equivalent, while a Virginia Tech undergraduate or a student elsewhere, that course must be replaced with another course approved by the Advisory Committee. A student will not be allowed to repeat a Virginia Tech course (or an equivalent course from another institution) for a grade. A required AOE course can only be replaced with another AOE course. [1] Non-thesis Ocean Engineering M.S. candidates may take both AOE 5315-5316: Naval Ship Design to meet the 6 unit Capstone Naval Ship Design Project in place of 6 units of AOE 5904: Project and Report. [2] It is strongly recommended that students who wish to take AOE 6744, first take AOE 5744, Linear Systems Theory or an equivalent course on linear, time-varying systems. [3] If AOE 4274: Computer-Based Design of Ocean Structures has already been taken, then one of the following two courses must be substituted: AOE 5024: Vehicle Structures or AOE 5374: Rationally-Based Design of Ocean Structures. [4] It is strongly recommended that students who wish to take AOE 5314: Naval Ship System Design, first take AOE 4264: Principles of Naval Engineering.

GRADUATE COURSES (AOE)

AOE 5024:

Vehicle Structures

Exact and approximate methods for analysis and design of aerospace and marine structures. Stresses, strains, constitutive equations, boundary value problems, and two-dimensional elasticity; torsion; variational methods; virtual work and energy principles; structural mechanics theorems; traditional approximate methods; and laminated plates.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5034 (ESM 5304):

Mechanical and Structural Vibrations

Free and forced vibrations of single-degree-of-freedom systems, multi-degree-of-freedom systems, continuous systems including strings, rods, bars, and beams. Natural frequencies and modes. Rigid Body modes. Proportional and nonproportional damping. Response to harmonic, periodic, and nonperiodic excitations. Solutions by modal analysis, direct integration and Fourier Series. Approximate methods including assumed modes and the Rayleigh-Ritz method. Advanced topics chosen by instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5024

Corequisite(s):

AOE 5044:

Dynamic Stability of Structures

Modern structural stability analysis; static and dynamic instability; conservative and nonconservative systems; multiple loads; and Liapunov stability analysis. Applications to columns, rotating shafts, pipes conveying fluid, and airplane panels. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ESM 4074 (UG) OR AOE 3034 (UG)

Corequisite(s):

AOE 5054 (ESM 5454):

Elastic Stability

Stability of elastic structural components under conservative loads; precise definitions of stability; energy approaches; Rayleigh-Ritz and Galerkin methods; and applications to column, arches, plates, and shells. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3124 (UG) OR CEE 3404 (UG)

Corequisite(s):

AOE 5064:

Structural Optimization

Structural optimization via calculus of variations. Application of techniques of mathematical programming to optimize trusses, beams, frames, columns, and other structures. Sensitivity calculation of structural response. Approximation techniques and dual and optimality criteria methods. A background in optimization is necessary. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5074:

Advanced Ship Structural Analysis

Computer modeling of ship structures. Levels and types of structural failures in ships. Elastic and inelastic plate bending. Elastic and inelastic buckling of columns, plates and stiffened panels. Computer programs for ultimate strength analysis of ships. Sample applications. Pre: Graduate standing in Engineering.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5024

Corequisite(s):

AOE 5084:

Submarine Design

Application of engineering disciplines to the design of a steam turbine propelled nuclear submarine. The disciplines involved are fluid mechanics, solid state mechanics, structures, machine design, thermodynamics and heat transfer.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5104:

Advanced Aero and Hydrodynamics

Vector analysis concepts; fluid stress and strain, kinematics of fluid flows including vorticity; dynamics of inviscid incompressible flow; and potential flow theory with applications to lifting and non-lifting bodies.

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5114:

High Speed Aerodynamics

Aerothermodynamic phenomena and shock waves. Linearized subsonic and supersonic flow past planar surfaces and bodies of revolution.

Theory of transonic aerodynamics including study of mixed flow.

Similarity laws. Mathematical representation of inviscid compressible flows in equilibrium. Potential function, stream function, rotationality and geometrical considerations. Method of characteristics applied to hyperbolic flow fields. Discussion of techniques for solution of elliptic flow fields.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG)

Corequisite(s):

AOE 5135 (ME 5135):

Vehicle Propulsion

Aerothermodynamics of gas turbines and rockets: cycle analysis of turbojets, turbofans, prop fans, and turbo props. Analysis of ramjets and scramjets. Performance of inlets, combustors, and nozzles. Elementary theory of turbomachinery. Liquid and solid propellant chemical rockets. Electrostatic, electromagnetic, and electrothermal propulsion. Integrated rocket-ramjet. Fuels and propulsion systems for future transportation system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG), ME 3134 (UG)

Corequisite(s):

AOE 5136:

Vehicle Propulsion

Aerothermodynamics of gas turbines and rockets: cycle analysis of turbojets, turbofans, prop fans, and turbo props. Analysis of ramjets and scramjets. Performance of inlets, combustors, and nozzles. Elementary theory of turbomachinery. Liquid and solid propellant chemical rockets. Electrostatic, electromagnetic, and electrothermal propulsion. Integrated rocket-ramjet. Fuels and propulsion systems for future transportation

system.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3114 (UG), ME 3134 (UG)

Corequisite(s):

AOE 5144:

Boundary Layer Theory and Heat Transfer

Conservation equations and constitutive relations, exact Navier Stokes solutions; boundary layer approximation and special solutions; approximate methods; compressibility and heat and mass transfer effects; and numerical methods and simple turbulence models.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5104 (UG)

Corequisite(s):

AOE 5204:

Vehicle Dynamics and Control

Relevant rigid body kinematics and dynamics fundamentals for vehicles such as aircraft, spacecraft, and ships. Provides foundation for advanced courses and research on dynamics and control of vehicles. Review of particle motion and application to aircraft performance and satellite orbital mechanics. Rigorous modeling of rotational and translational motion of rigid bodies. Linearization of equations of motion for stability analysis, modal analysis, control system synthesis, with introduction to classical control system concepts. Sensors and actuators commonly used on vehicles. Specific examples from aircraft, missiles, spacecraft, rockets, ships, and submersibles.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3134 (UG), AOE 3234 (UG) OR AOE 4140 (UG)

Corequisite(s):

AOE 5214:

Aircraft Dynamics and Control

General equations of aero/hydrodynamic vehicular motion including the effects of flexibility and changing mass. Consideration of buoyant, aerodynamic, gravitational and thrust forces, jet damping, thrust offset, and rotating machinery contributions. Reduction of equations to linearized form, aero/hydrodynamic stability derivatives. Stability and

response characteristics. Application of classical control theory to aircraft control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3134 (UG)

Corequisite(s):

AOE 5234:

Orbital Mechanics

Lagrange's equations of motion, two-body problem, conic sections, Kepler's laws, orbit determination. Multi-body problems and integrals of motion. Fundamentals of perturbation theory, variation of parameters, and Lagrange's planetary equations. Regularization and alternative formulations of equations of motion.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 4134 (UG)

Corequisite(s):

AOE 5244:

Optimization Techniques

Ordinary minimum problems with constraints. The classical multiplier method, descent methods, and quasi-Newton methods. Optimal control and the maximum principle. Second-order necessary conditions. Singular control. Continuous gradient methods, conjugate gradients.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3134 (UG), MATH 4564 (UG)

Corequisite(s):

AOE 5304:

Advanced Naval Architecture

Engineering analysis methods for evaluating the hydrostatic, hydrodynamic, and structural characteristics of surface ships and submarines. Methods employed in ship design include analytical, statistical, and experimental approaches. Both hull and propulsor analysis techniques are covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5305:

Marine Engineering

In depth analysis and design of major ship propulsion system and machinery components. 5305: Propellers, shafting and gearing. Intro. to boilers, steam and gas turbines, nuclear power plants and diesels. 5306: Advanced study of diesels and gas turbines. Internal combustion engines. Shipboard HVAC, pump and motor systems. Cost estimation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ME 3134 (UG)

Corequisite(s):

AOE 5306:

Marine Engineering

In depth analysis and design of major ship propulsion system and machinery components. 5305: Propellers, shafting and gearing. Intro. to boilers, steam and gas turbines, nuclear power plants and diesels. 5306: Advanced study of diesels and gas turbines. Internal combustion engines. Shipboard HVAC, pump and motor systems. Cost estimation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 3134 (UG)

Corequisite(s):

AOE 5314:

Naval Ship System Design and Effectiveness

Concepts, theory, and methods for the engineering, design, integration, and assessment of naval ship systems. Modeling of system effectiveness for multidisciplinary and multi-objective design optimization. Mathematical theory for naval effectiveness models (OEMs) and physics-based mechanical, electrical, sensor, control, and weapon systems models to assess total-ship effectiveness in anti-air warfare, target coverage, and fleet air warfare. System integration, interfaces, and analyses considering ship arrangements, electromagnetic compatibility, signatures, system deactivation diagrams, reliability, maintenance, modularity, system power, shock and weapons effects, fire analysis, damage control, and overall system survivability.

Credit Hour(s): 3

Lecture Hour(s): 3

433 Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5304, AOE 5405

Corequisite(s):

AOE 5315:

Naval Ship Design

Capstone naval ship design concept exploration including the study and application of the system engineering process to the simultaneous development of naval ship requirements, selection of ship technologies, and definition of a baseline naval ship design. Hullform, machinery, ship synthesis and balance, metrics (including Overall Measure of Effectiveness, technology risk, and cost) and design optimization in the context of a naval ship design project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5304, AOE 5305, AOE 5314, AOE 5334, AOE 5074

Corequisite(s):

AOE 5316:

Naval Ship Design

Development of a naval ship baseline design including hullform, combat systems, topside arrangements, internal subdivision and tankage, power and propulsion, auxiliary machinery, general arrangements, machinery arrangements, human systems, structural design, assessments of intact and damage stability, shock and survivability, weights, space, seakeeping, cost, risk, and overall balance and feasibility.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5315 (UG)

Corequisite(s):

AOE 5334:

Advanced Ship Dynamics

Derivation of the equations of motion of a ship; waves and wave forces on structures; description of wave statistics and spectral representation in a given sea state; ship response in regular waves; ship response in random waves.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3234 (UG), MATH 4564 (UG)

Corequisite(s):

AOE 5344:

Nonlinear Control of Mechanical Systems

Methods of nonlinear control, emphasizing techniques applicable to mechanical systems. Nonlinear system theory and stability analysis. Nonlinear controllability and observability. Input-output properties. Passive and dissipative systems and stability of interconnected systems. Common nonlinear control design techniques: feedback linearization; sliding mode control; adaptive control. Techniques for mechanical systems: potential shaping; kinetic shaping. Emphasis on applications to vehicle control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 4004 (UG)

Corequisite(s):

AOE 5374:

Rationally-Based Design of Ocean Structures

Methodology of rationally-based optimum structural design of ships based on explicit calculation of failure loads. Torsion of thin-wall sections. Ultimate limit states of stiffened cylinders. Structural optimization of stiffened panels. Computer programs for ultimate strength analysis and structural design of ships, submarines and offshore platforms. Sample applications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5074 (UG)

Corequisite(s):

AOE 5434G:

Advanced Introduction to Computational Fluid Dynamics

Euler and Navier-Stokes equations governing the flow of gas 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. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

434 Prerequisite(s):

Corequisite(s):

AOE 5444G:

Adv Dyn of High-Speed Craft

Study of the dynamics of high-speed craft, including surface effects ships, hydrofoil vessels, semi-displacement monohulls and catamarans, and planning vessels. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5454:

Advanced Aerospace and Ocean Engineering Instrumentation

An advanced treatment of the principles of measurement systems; standards, accuracy, uncertainty and statistical concepts, and signal processing. Detectors, transducers, and instruments for aerospace and ocean engineering. Hot-wire and laser anemometry. Signal conditioning systems and readout devices, digital data acquisition principles.

Electronics and electrical test instruments. Case studies of practical instrumentation systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 3014 (UG), AOE 3034 (UG)

Corequisite(s):

AOE 5504:

Aerospace and Ocean Engineering

Introduction of the natural space environments: solar wind, planet atmosphere, ionosphere, magnetosphere, comets, and meteoroids.

Introduction of the induced spacecraft environments. Advanced treatment of the physics and effects of atmospheric interactions, plasma interactions, radiation interactions, hypervelocity impacts, spacecraft contamination, and interactions induced by electric propulsion.

Applications to spacecraft design. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 4174 (UG), AOE 4404 (UG)

Corequisite(s):

AOE 5734 (ECE 5734) (ME 5584):

Convex Optimization

Recognizing and solving convex optimization problems. Convex sets, functions, and optimization problems. Least-squares, linear, and quadratic optimization. Geometric and semidefinite programming. Vector optimization. Duality theory. Convex relaxations. Approximation, fitting, and statistical estimation. Geometric problems. Control and trajectory planning. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5744 (ME 5544) (ECE 5744):

Linear Systems Theory

Advanced introduction to the theory of time-varying and time-invariant linear systems represented by state equations; solutions of linear systems, uniform stability and other stability criteria, uniform observability and controllability, state feedback and observers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4634 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

AOE 5754 (ECE 5754) (ME 5554):

Applied Linear Systems

Develop an applied understanding of state-space representations for linear time invariant multi-input multi-output dynamic systems in both time domain and frequency domain. Introduction to modern state-space control methods; state feedback and output feedback. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

AOE 5764 (ME 5564) (ECE 5764):

Analysis and design of sampled-data systems, extraction of discrete-time dynamic models from experimental data, and implementation of dynamic compensators on digital processors. In-depth design experience with LQR optimal control and an introduction to Kalman filtering. Realistic design problems with numerical simulations of practical implementations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5744 OR AOE 5754 OR ME 5554 OR ME 5544 OR ECE 5744 OR ECE 5754

Corequisite(s):

AOE 5774 (ECE 5774) (ME 5574):

Nonlinear Systems Theory

Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations: existence and uniqueness of solutions; continuous dependence on parameters; stability of equilibria and stability analysis techniques; input-to-state stability; input-output stability; nonlinear design techniques including input-state and input-output feedback linearization, backstepping, and sliding mode control.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 4405 (UG) OR ECE 4405 OR ECE 4624 (UG) OR ECE 4624 OR ECE 4634 (UG) OR ECE 4634 OR ME 4504 (UG) OR ME 4504 OR AOE 4004 (UG) OR AOE 4004

Corequisite(s):

AOE 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

AOE 5914:

Autonomous Systems Seminar

Weekly technical presentations from local and visiting scholars on current topics related to the theory, design and development, and application of autonomous vehicle systems. Pre-Requisite: Graduate Standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5944:

Seminar

Discussion of current research topics in Aerospace and Ocean Engineering by local and visiting scholars. This course cannot be used to fulfill the minimum requirements of 30 hours toward the Master's Degree or 90 hours toward the Ph.D. Degree in Aerospace and Ocean Engineering. May be repeated.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

AOE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

AOE 6024:**Aeroelasticity**

Discussion of the aeroelastic phenomena including flutter, divergence, control surface effectiveness, and lift redistribution; and introduction to traditional and modern methods of analysis and remedies for aeroelastic problems of flight vehicles.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5034, AOE 5104, AOE 5214

Corequisite(s):

AOE 6114:**Transonic Aerodynamics**

Basic features of transonic flows, similarity methods, and hodograph methods. Major emphasis on finite difference procedures including type dependent relaxation procedures for potential flows and time asymptotic Euler solutions. Grid generation methods, inverse design procedures, unsteady flow, wind tunnel/wall interference, and shock wave/boundary layer interactions.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG), AOE 4404 (UG), AOE 5144 (UG)

Corequisite(s):

AOE 6124:**Hypersonic Aerodynamics**

Theory of inviscid hypersonic flows; blunt body and Newtonian aerodynamics; nonlinear small disturbance theory; and approximate methods and comparisons with experiment. Viscous hypersonic flow theory; skin friction and heat transfer on blunt and slender bodies; and vorticity, entropy layer, and viscous-inviscid inter-action effects.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 5114 (UG)

Corequisite(s):

AOE 6145:**Computational Fluid Dynamics**

Computational methods for incompressible, compressible, and viscous fluid flows. Theoretical and numerical developments for wave equation, heat equation, Poissons equation, and Burgers equation. Applications to inviscid subsonic, transonic, and supersonic flows, viscous boundary layer, Navier Stokes, thin layer equations, and grid generation techniques.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): AOE 3114 (UG), AOE 4404 (UG), AOE 5104 (UG)

Corequisite(s):

AOE 6154:**Turbulent Shear Flow**

Advanced treatment of the physical phenomena of turbulent boundary layers, jets, wakes, and duct flows; coherent structures; entrainment, bursting, vortex dynamics; and unsteady, wall, and freestream turbulence effects.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5144 (UG)

Corequisite(s):

AOE 6204:**Adv Vehicle Dynamics & Control**

Topics in the dynamics and control of systems including airplanes, helicopters, spacecraft, and structures. Physics and data-based modeling from the control system designer's perspective. Structure of the control-oriented equations of motion in relation to robust control design. Bio-inspired design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5024, AOE 5204

Corequisite(s):

AOE 6234:**Spacecraft Dynamics and Control**

Rigid body kinematics and spacecraft attitude descriptions. Attitude dynamics, motion about the center of mass, gravity gradient, and stability. Methods of attitude control both active (momentum exchange devices, thrusting) and passive (spin stabilization). Small and large angle feedback control laws. Attitude maneuvers of hybrid bodies containing both rigid and flexible components. Pre: AOE 5204, or permission of instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 4134 (UG), AOE 5234 (UG)

Corequisite(s):

AOE 6254:**Intelligent Control**

Intelligent control design of nonlinear systems, autonomous vehicles, including unmanned aerial vehicles, autonomous underwater vehicles, and spacecraft. Review of methods for stability analysis and robust control. Adaptive control design methodologies. Robustness of adaptive systems. Vision based sensors. Multivariable adaptive control. Output feedback methods.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AOE 5344 (UG) OR ECE 6414 (UG)

Corequisite(s):

AOE 6434 (ME 6434):**Computational Fluid Dynamics and Heat Transfer**

Overview of numerical methods used in the study of computational fluid dynamics (CFD) and heat transfer. Spatio-temporal finite-difference, finite-volume discretizations, solution of linear systems with direct and iterative methods, algorithms for solving the Navier Stokes and energy equations, and turbulence modeling. Applications to inviscid subsonic, transonic, and supersonic flows and viscous boundary layer. Theory reinforced with hands on programming assignments and the application of commercial CFD packages to select problems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ME 5404, ME 5314, (AOE 3114 (UG) OR AOE 3114), (ME 4404 (UG) OR ME 4404), ME 5104

Corequisite(s):

AOE 6444 (CS 6444) (ME 6444):**Verification and Validation in Scientific Computing**

Applicable to scientific and engineering models described by partial differential or integral equations. Software engineering, code verification, and the method of manufactured solutions for generating exact solutions. Estimation of numerical approximation errors in scientific computing. Design and execution of experiments for model validation and model accuracy assessment. Propagation of aleatory and epistemic uncertainty through models. Estimation of total prediction uncertainty in scientific computing simulations. Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AOE 6744 (ECE 6744) (ME 6544):**Linear Control Theory**

Advanced introduction to the theory of optimal control of time-varying and time-invariant linear systems; Solutions to the linear-quadratic regulator, optimal filtering, and linear-quadratic-gaussian problems; Robustness analysis and techniques to enhance robustness of controllers.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECE 5744 OR ECE 5754 OR ME 5544 OR ME 5554 OR AOE 5744 OR AOE 5754

Corequisite(s):

AOE 6774 (ECE 6774) (ME 6574):**Adaptive Control Systems**

Introduction to the theory and methodology used to design adaptive controllers for uncertain systems, addressing issue such as input constraints, disturbance rejection, partial measurements, and robustness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ECE 5774, ECE 5744) OR (ME 5544, ME 5574) OR (AOE 5774, AOE 5744)

AOE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AOE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

ARCHITECTURE

Henri de Hahn, Head

Emeriti Faculty: Ellen Braaten; Dayton Egger; Dennis Jones;

Professors: Kathryn Albright; Markus Breitschmid; Salahuddin Choudhury; Donna

Dunay; Robert Dunay; Jaan Holt; James Jones; Susan Piedmont-Palladino;

Humberto Rodriguez-Camilloni; Hans Rott; Robert Schubert; Mehdi Setareh; Frank

Weiner; Joseph Wheeler;

Associate Professors: Mario Cortes; Edward Dorsa; David Dugas; Kay Edge;

Paul Emmons; Michael Ermann; Marcia Feuerstein; William Galloway; Howard

Gartner; William Green; Shelley Martin; Margarita McGrath; Vance Pittman; Helene

Renard; Heinrich Schnoedt; Gregory Tew; Steven Thompson; Lisa Tucker; Mitzi

Vernon;

Assistant Professors: Lindy Balls Huling; James Bassett; Hilary Bryon; Elizabeth

Grant; Aki Ishida; Mark Schneider; Akshay Sharma; Matthew Wagner;

Graduate Coordinator: garch@vt.edu

School of Architecture + Design: <http://archdesign.vt.edu/architecture/>

Master of Architecture The graduate curriculum is structured to allow flexibility and to accommodate diverse student needs. This is accomplished by offering a combination of choices of studies available within the various program options. The M.Arch. 1 option results in a post-professional degree, while the M.Arch. 2 and 3 options result in the conferring of a first professional degree, fully accredited by the National Architectural Accrediting Board. For details see <http://archdesign.vt.edu/architecture/Central> to the academic structure of these several options is the design laboratory. The various design

laboratories are oriented toward formulation and resolution of design questions at a broad range of scales. In addition to fostering a mastery of the design process, the design laboratory is intended to cultivate a foundation for design through the study of concepts and principles of form generation, through education of an environmental awareness and aesthetic judgment, through study of the syntax of architectural language, and through the development of technical knowledge of the processes of fabrication and construction. These learning-oriented laboratories encourage the use of previously acquired knowledge, skills, and experience gained in the architectural profession and in other academic disciplines.

SPECIAL FACILITIES

Research and Outreach Centers

Burchard Hall

Burruss Hall

Cowgill Hall

Environmental Systems Lab

Research and Demonstration Facility

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (577.0)

Computer: (233.0)

iBT: (90.0)

TOEFL

Paper: (577.0)

iBT: (90.0)

Master of Science in Architecture The Master of Science in Architecture program offers the opportunity for advanced study and research in specialized areas related to building design, construction, and operations over a broad range of scales, providing the basis for diverse career paths and/or entry into a Ph.D.- level program. The M.S. is not directed toward professional licensing and therefore is not accredited by the NAAB as a "first professional degree." While an undergraduate degree in architecture or a related field is not required, applicants must demonstrate relevant background and experience, as well as capabilities for undertaking advanced academic study. The Master of Science program allows a student to conduct a research-based program of study which can be expected to contribute to the body of knowledge in the design and building professions, and may lead to future study in the doctoral program, where advanced standing may be awarded for acceptable graduate credits earned at the master's level. Students will develop their own programs of study in cooperation with appropriate

faculty and in consideration of the courses and facilities available. A brief description of the available research concentrations follows: Building Science: Studies in the category of Building Science focus on various issues over a broad range of scales and may concentrate on the following (or other) areas: energy and building design; mechanical systems and large buildings; lighting and day-lighting; natural ventilation and air flow; indoor air quality; acoustics and theater design; and building structure, assembly, and/or economics. Interior Design: This concentration allows those with professional degrees in Interior Design or closely related areas the opportunity for advanced research which is expected to add to the body of knowledge in the discipline of Interior Design. Potential research areas include design practice, history of interiors, computer applications in interior design, and environmental factors related to interiors. Urban Design: This concentration allows students an opportunity to engage in urban design research, addressing the design of safe, healthy, and sustainable urban environments.

Emphasis is on the physical form of cities and the complex forces that shape them. Focused on the general underlying themes of security, resilience, health, and sustainability, possible research areas include but are not limited to mobility and infrastructure, conservation and preservation, and urban places and dwellings. The Urban Design program will be housed in the facilities of the Washington-Alexandria Architecture Center (WAAC) in Alexandria, VA. The Master of Science degree is awarded upon satisfactory completion of an approved plan of study of at least 36 credit hours, normally including a thesis representing up to 10 hours of the total hours required.

MArch Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (577.0)

Computer: (233.0)

iBT: (90.0)

TOEFL

Paper: (550.0)

iBT: (80.0)

Master of Architecture Post-Professional Degree Program M.Arch.1, Advanced Research and Design: The M.Arch.1, Advanced Research and Design Program is a graduate degree program intended for students who have previously obtained a five-year, professional degree in architecture (B.Arch.). Students in this program may receive advanced standing, as determined by the graduate program faculty, for up to 24 credit hours toward the completion of the 54 semester credit hours required for graduation, resulting in a typical program of study of 30 semester credit hours (minimum), generally requiring approx. one calendar year of study. Students are provided the opportunity and academic resources necessary to pursue a definitive, experimental, design investigation or research in a design-related subject area, according to their special interests. Students in the M.Arch.1 program may elect to enroll at the Washington-Alexandria Center for all or a portion of their required studies. The one-year Master of Architecture from Virginia Tech is a post-professional degree and does not constitute an accredited first professional degree in architecture. International applicants who hold architecture degrees from schools outside the U.S. and who aspire to professional licensure in the U.S. are advised to apply to the M.Arch.2 program. First Professional Degree Programs M.Arch.2, Advanced Professional Studies: An Advanced Professional Studies option (M.Arch.2) is offered for the student who has previously obtained

a four-year, pre-professional baccalaureate degree in architecture. The first year of study continues the student's professional building design education and related technical and history/theory studies. The second year is reserved for preparation of a design thesis demonstrative of the student's academic accomplishment and professional potential. Students in this program typically complete 54 (min.) credit hours, normally requiring at least two academic years (four semesters) of study. Students in the M.Arch.2 program may elect to enroll at the Washington-Alexandria Center for all or a portion of their required studies and/or may spend a semester participating in the Europe Study Abroad Travel Program or in residence at the Center for European Studies and Architecture (CESA) in Riva San Vitale, Switzerland. M.Arch.3, Comprehensive Professional Studies A Comprehensive Professional Studies option (M.Arch.3) is provided for graduate applicants with degrees in fields other than architecture. The student is presumed to have undertaken little or no concentration in architecture prior to enrollment in the program. In addition to the 54 (min.) graduate credit hours required for the degree, students in the M.Arch.3 option complete 27 credit hours of qualifying year academic work, engaging in studies to provide a foundation of environmental design experiences and to promote a basic understanding of the discipline. Upon successful completion of the qualifying year, students advance through a sequence of studies providing for development of building design skills and knowledge of building systems and the technical processes of construction. During the final year of the curriculum, students pursue individual study interests and prepare a thesis. This program usually requires at least three and one half years (three academic years, plus one required summer) of study. Students in the M.Arch.3 program may elect to enroll at the Washington-Alexandria Center for the final, thesis year and/or may spend a semester participating in the Europe Study Abroad Travel Program or in residence at the Center for European Studies and Architecture (CESA) in Riva San Vitale, Switzerland. Accredited degrees: The M.Arch.2 and M.Arch.3 programs are fully accredited by the National Architectural Accrediting Board as first professional degree programs in architecture. 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 US 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. Masters 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.

GRADUATE COURSES (ARCH)

ARCH 5035:

Advanced Environmental Controls

Advanced studies of environmental controls, the system, and its physical environmental factors, including development in building systems, urban systems, service systems, construction systems, materials and component systems, psycho-physical consideration, systems analysis, and computer technology. May be repeated for a maximum of 12 credit

hours in varied options offered.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ARCH 4755 (UG), ARCH 4756 (UG)

Corequisite(s):

ARCH 5036:

Advanced Environmental Controls

Advanced studies of environmental controls, the system, and its physical environmental factors, including development in building systems, urban systems, service systems, construction systems, materials and component systems, psycho-physical consideration, systems analysis, and computer technology. May be repeated for a maximum of 12 credit hours in varied options offered.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ARCH 4755 (UG), ARCH 4756 (UG)

Corequisite(s):

ARCH 5044:

International Construction Practices

This course contrasts aspects of the US construction industry with similar yet fundamentally different operating procedures utilized within the international construction community. Areas of concentration include participant organization and culture, project delivery methods, multi-national teams and unique operational and management activities essential in the international market. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5044G:

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. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5045:

Environmental Design Research

Methods for identifying, evaluating, and enhancing the knowledge base for design decisions at scales ranging from room to region. Course emphasizes analytic and empirical approaches to characterizing attributes of the physical environments and their transformation into design variables. Sources of emerging knowledge and systems for maintaining technical currency are identified. Bachelor's Degree in Environmental Design (B.S. Arch, B. Arch, B.L. Arch) required. Co: UAP 5495 or UAP 5496 or EDAE 5300.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5046:

Environmental Design Research I, II

Methods for identifying, evaluating, and enhancing the knowledge base for design decisions at scales ranging from room to region. Course emphasizes analytic and empirical approaches to characterizing attributes of the physical environments and their transformation into design variables. Sources of emerging knowledge and systems for maintaining technical currency are identified. Bachelor's Degree in Environmental Design (B.S. Arch, B. Arch, B.L. Arch) required. Co: UAP 5495 or UAP 5496 or EDAE 5300.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5055:

Advanced Building Structures

Study of building forms and structure systems ranging from horizontal-span structures to skyscrapers; preliminary design of masonry buildings, skeletons, tubes, soft and rigid surface structures by considering the complexity of load action that includes wind, seismic, and hidden loads.

441 Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4775 (UG), ARCH 4776 (UG)

Corequisite(s):

ARCH 5056:

Advanced Building Structures

Study of building forms and structure systems ranging from horizontal-span structures to skyscrapers; preliminary design of masonry buildings, skeletons, tubes, soft and rigid surface structures by considering the complexity of load action that includes wind, seismic, and hidden loads.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4775 (UG), ARCH 4776 (UG)

Corequisite(s):

ARCH 5064:

Topics in Computer Applications in Design

Computer system fundamentals. Introduction to programming. Emphasis on computer graphics in 2 and 3-space geometry and graphics-related topics employing several languages. Computer usage in architectural design and production. Exploration of available hard and software through advanced design issues. May be repeated for a maximum of 12 credit hours with different content or topics.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ARCH 4716 (UG)

Corequisite(s):

ARCH 5115:

Media and the Environment Workshop

The role of various media of visual communication as tools of documentation, analysis, and creation in the designed visual environment. Skills in photography, film, video techniques, and printmaking graphics will be developed in specific relation to environmental design study and presentation.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s): ARCH 5715, ARCH 5716, ARCH 5994

ARCH 5116:

Media and the Environment Workshop

The role of various media of visual communication as tools of documentation, analysis, and creation in the designed visual environment. Skills in photography, film, video techniques, and printmaking graphics will be developed in specific relation to environmental design study and presentation.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s): ARCH 5715, ARCH 5716, ARCH 5994

ARCH 5124:

Land Development for Constructed Facilities

This course covers how to get a piece of undeveloped Real-estate from idea to the finished product. It discusses the construction management interface between Site Engineering and Real-estate Marketing. Topics covered include: market influences, working with regulatory agencies, zoning, economic considerations, developing an optimum plan, cost and schedule, engineering requirements, environmental impact, financing, and delivering a final product. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ARCH 2014 (UG)

Corequisite(s):

ARCH 5125:

Materials Processes Workshop

Characteristics, properties, and uses of various materials and processes as tools of study, analysis, and presentation of the designed environment. The proportion, form, and sectional analysis of hand, wheel, and cast objects are studied. Uses of these materials and the technical process involved are emphasized. Workshop provides framework for design of small scale objects which can relate to environmental design and larger urban scale issues. Co: 5705, 5706 or 5994

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

442 Corequisite(s): ARCH 5705

Prerequisite(s): ARCH 4716 (UG)

Corequisite(s):

ARCH 5126:

Materials Processes Workshop

Characteristics, properties, and uses of various materials and processes as tools of study, analysis, and presentation of the designed environment. The proportion, form, and sectional analysis of hand, wheel, and cast objects are studied. Uses of these materials and the technical process involved are emphasized. Workshop provides framework for design of small scale objects which can relate to environmental design and larger urban scale issues. Co: 5705, 5706 or 5994.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s): ARCH 5706

ARCH 5134:

Topics in Architecture History and Theory

Study and critical evaluation of selected current and historical issues in architecture and environmental design. Materials studied will be in the form of projects and writings of key designers, interpretations by leading critics and analysis by historians. Topics will be selected from such areas as: theories of change in culture and architecture; concepts of expression, image, symbol, and form; problems of functional, rational, and social analysis; perception of space and organization. May be repeated for a maximum of 12 credit hours in varied options offered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4705 (UG)

Corequisite(s):

ARCH 5515:

Arch & Systems Lab

Architecture design laboratory with concentration on development of intellectual and professional skills of analysis, synthesis, and evaluation in design problem solving. Focus on the interrelatedness of the various components of building structure and enclosure, integration of building environmental controls, and the contribution of materials and methods of construction to the design process.

Credit Hour(s): 0 OR 6

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

ARCH 5516:

Arch & Systems Lab

Architecture design laboratory with concentration on development of intellectual and professional skills of analysis, synthesis, and evaluation in design problem solving. Focus on the interrelatedness of the various components of building structure and enclosure, integration of building environmental controls, and the contribution of materials and methods of construction to the design process.

Credit Hour(s): 0 OR 6

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ARCH 4716 (UG)

Corequisite(s):

ARCH 5565:

Building Materials and Construction

Building materials, elements, and construction methods, including wood, masonry, concrete, and steel construction, building foundations and sitework, building and zoning codes, building cost considerations, interior finishes, and building envelope systems, including cladding, windows and window walls, curtain walls, roofing, and insulation; emphasis on knowledge of building materials and construction methods in support of architectural design decisions; historical development of building materials and ways of building, standard building practice, and analysis of the construction of significant works of architecture. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5566:

Building Materials and Construction

Building materials, elements, and construction methods, including wood, masonry, concrete, and steel construction, building foundations and sitework, building and zoning codes, building cost considerations, interior finishes, and building envelope systems, including cladding, windows and window walls, curtain walls, roofing, and insulation emphasis on knowledge of building materials and construction methods in support of architectural design decisions; historical development of building materials and ways of building, standard building practice, and analysis

of the construction of significant works of architecture. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5614:

Theory of Urban Form

Urban forms related to functions; analysis of socioeconomic, political, historical, geographic, and cultural forces influencing urban form.

Concepts of idealized urban forms and theoretical models of urban configuration.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4705 (UG)

Corequisite(s):

ARCH 5624:

Urban Design Seminar

Current topics in urban design. Topics may include: theoretical, conceptual and practical concerns in the generation of urban spatial form; the roles of public and private interests in shaping urban form; the effects of urban intensification on the quality of public spaces; environmental issues in urban design; the role of public policy and regulatory mechanisms; the genesis and development of urban typologies. Each seminar will address one of these or related subject areas. Course may be repeated with a different subject for a maximum of 12 credits. I,II.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 5614 (UG)

Corequisite(s):

ARCH 5634:

Urban Design Studio

Urban design studio projects involving the translation of design and planning theory and methodology to actual form-giving proposals for the urban context. Emphasis will be on the development of urban tectonic form in response to functional and behavioral planning, symbolic and aesthetic factors. May be repeated for a maximum of 12 credit hours.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4715 (UG)

Corequisite(s):

ARCH 5644:

Comparative Urbanism Seminar

Explores current issues, situations, and developments in diverse urban settlements across cultures. Direct experience of selected cities will be supported by contemporary and historic readings, maps and drawings to illuminate differential technological, environmental, economic, social and cultural forces shaping subject cities. Research methods applicable to urban design will be discussed. Choice of cities and areas of focus will be determined by students based on their thesis research proposals. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5705:

Architecture and Urbanism Seminar

Review of contemporary concepts in architectural design in the context of the urban environment. Significant architectural works of the twentieth century and the theories of their authors will be studied for an understanding of their contribution to the language of architecture. The attitudes and phenomena which have led to the making of the particular culture of our time will be studied for their impact on the built urban environment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 5516 (UG)

Corequisite(s):

ARCH 5706:

Architecture and Urbanism Seminar

Review of contemporary concepts in architectural design in the context of the urban environment. Significant architectural works of the twentieth century and the theories of their authors will be studied for an understanding of their contribution to the language of architecture. The attitudes and phenomena which have led to the making of the particular

culture of our time will be studied for their impact on the built urban environment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 5516 (UG)

Corequisite(s):

ARCH 5715:

Architecture and Urbanism Laboratory

Advanced design laboratory for identifying needs, resources and operational methodologies across an expanded range of environmental scales. The scope of design includes the relation of the individual building to the environment in comprehensive terms, with particular emphasis on the complexity which exists at the urban scale. Methods for the identification of socio-cultural needs and the coordination of complex variables, information, and resources, leading to the conceptualization and development of design of the components of the built environment.

Credit Hour(s): 0 OR 6

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5716:

Architecture and Urbanism Laboratory

Advanced design laboratory for identifying needs, resources and operational methodologies across an expanded range of environmental scales. The scope of design includes the relation of the individual building to the environment in comprehensive terms, with particular emphasis on the complexity which exists at the urban scale. Methods for the identification of socio-cultural needs and the coordination of complex variables, information, and resources, leading to the conceptualization and development of design of the components of the built environment.

Credit Hour(s): 0 OR 6

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ARCH 5755:

Advanced Design Laboratory

Complex environmental design problems related to social, cultural, and historical issues examined for contribution to developing appropriate

architectural form and aesthetic. Laboratory will focus on research and development of graduate design projects at a range of scales: product, architectural, urban; based on individual interests.

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s): ARCH 4716 (UG)

Corequisite(s):

ARCH 5755G:

Building Environmental 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 system performance. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4706 (UG)

Corequisite(s):

ARCH 5756:

Advanced Design Laboratory

Complex environmental design problems related to social, cultural, and historical issues examined for contribution to developing appropriate architectural form and aesthetic. Laboratory will focus on research and development of graduate design projects at a range of scales: product, architectural, urban; based on individual interests.

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s): ARCH 4716 (UG)

Corequisite(s):

ARCH 5756G:

Building Environmental 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. Pre-requisite:

Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): ARCH 4706 (UG)
Corequisite(s):

ARCH 5775G:

Intermediate Bldg 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-requisite: Graduate Standing required
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): ESM 3704 (UG)
Corequisite(s):

ARCH 5776G:

Intermediate Bldg Systems

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-requisite: Graduate Standing required.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s): ESM 3704 (UG)
Corequisite(s):

ARCH 5894:

Final Examination

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ARCH 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

ARCH 5974:

Independent Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

ARCH 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ARCH 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

ARCH 6005:

Movements in Architecture and Western Thought

Platform for advanced studies in the historic and canonic evidence of the objective reality of architecture. Establishes a basis on which an emerging designer can build for future work and inquiry. Pre-requisite: Graduate Standing required.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ARCH 6006:**Movements in Architecture and Western Thought**

Platform for advanced studies in the historic and canonic evidence of the objective reality of architecture. Establishes a basic on which an emerging designer can build for future work and inquiry. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 6014:**Project and Company Management**

Study of the management of a construction project and a construction company. Project management includes finances, cash flows, cost control, project organization, and project planning. Company management includes company organization incorporation structure, procedures, finance, insurances, accounting, and operation. Case studies are emphasized. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ARCH 6984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ARCH 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ARCHITECTURE AND DESIGN RESEARCH

Henri de Hahn, Head

Professors: Markus Breitschmid; James Jones; Patrick Miller; Humberto Rodriguez-Camilloni; Mehdi Setareh;

Associate Professors: Dean Bork; Terry Clements; Paul Emmons; Marcia Feuerstein; Brian Katen; Paul Kelsch; Mintai Kim; Lisa Tucker;

Assistant Professors: Hilary Bryon; Elizabeth Grant; Mark Schneider;

Affiliated Faculty: David Lever;

Graduate Coordinator: garch@vt.edu

Graduate Chair: hpitt@vt.edu

Blacksburg Program: wolverine@vt.edu

Alexandria Program: pemmons@vt.edu

Landscape Architecture Track: mintkim@vt.edu

School of Architecture + Design: <http://archdesign.vt.edu/architecture/>

Washington Alexandria Achitecture Center: <http://www.waac.vt.edu/>

Ph.D. in Architecture and Design Research

<http://archdesign.vt.edu/architecture-design/phd>Degree Tracks within the

Ph.D. in Architecture and Design Research There are two major tracks within the Architecture and Design Research degree, each of which has topical areas. The requirements for the tracks vary slightly, but both provide significant flexibility for each student to develop a plan of study consistent with his or her academic goals. The two tracks are Architecture and Design Research. Architecture Track The Architecture track includes Architectural Representation and Education, Architectural History and Theory, Historic Preservation, and Computing and Representation. The Architecture track will share resources on the Blacksburg Campus and the Washington Alexandria Architecture Center in the National Capital Region. At the latter location, students have the best resources to develop their topics in architectural representation, since they can make use of the many research libraries available in the Washington, DC area, including the Library of Congress, National Building Museum library, American Institute of Architects Library, CASVA, Smithsonian Institution, the Dumbarton Oaks Library and many privately owned architectural archives. Design Research Track The Design Research track includes advanced study on Building Science, Industrial Design, Interior Design, and Landscape Architecture. The Landscape Architecture Track includes concentrations in: Design Learning and Professional Paradigms; Regenerative/Ecological Design, Planning and Technology; and Concepts of Community and Place.

The Design Research track is currently located in Blacksburg, VA at the Virginia Tech Main Campus. In this location students have the best resources to develop their topics in design research given that the faculty of the School of Architecture Design have established collaborative relationships with other university centers and institutions. Admission The faculty are seeking to admit a highly selective group of students who have master's degrees in closely allied fields, such as Architecture, Environmental Design, Building Science, Landscape Architecture, Architecture History and Theory, Interior Design, and Industrial Design. In addition to the application requirements of the Virginia Tech Graduate School and those pertaining to all graduate programs within the School of Architecture Design, applicants

to the PhD degree in Architecture and Design Research must submit a portfolio and a 2,500 word statement of research focus.

SPECIAL FACILITIES

School of Architecture + Design Facilities

Cowgill Hall Art & Architecture Library Burchard Hall Burruss Hall
Collegiate Square Studio Research + Demonstration Facility
Environmental Systems Laboratory Washington-Alexandria Center
Center for European Studies and Architecture

DEGREES OFFERED

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

Ph.D. in Architecture and Design Research: * The Graduate School requires each Ph.D. student to complete 90 semester hours of graduate study and dissertation. * All students, regardless of area of specialization, are required to complete a sequence of specific Architecture and Design Seminars. A two-semester sequence seminar will focus primarily on epistemology and the nature of discipline and practice of architecture, viewed in the context of architecture and the allied fields. Students will also enroll in a continuing seminar course required every semester of residence. In these seminars, Ph.D. students, the School faculty involved with the graduate program, and possible guests present their own research for critical review and feedback. The PhD students in the Architecture track must also pass a test of reading ability in a foreign language related to their selected topics (native languages and English do not fulfill this requirement). Students who are undertaking Ph.D. studies in landscape architecture should include the following courses in their program of study: ARCH 5045 - Design Research Methodology LAR 5724 - Scholarship in Landscape Architecture EDRE 6605 - Quantitative Research Methods in Education I (or equivalent approved by student's committee). EDRE 6504: Qualitative Methods in Educational Research I (or equivalent approved by student's graduate committee). * In addition, all students must complete a special Research Methods course organized by area of specialization. At the approval of the student's advisory committee the course may be also taken in the other area of specialization or outside of the school.

BUILDING/CONSTRUCTION SCIENCE AND MANAGEMENT

Yvan Beliveau, Head

Professors: Yvan Beliveau; Walid Thabet;

Associate Professors: Andrew McCoy; Thomas Mills; Annie Pearce; Georg

Reichard;

Assistant Professors: Muhsine Turkaslan Bulbul;

Visiting Faculty: David Goldsmith; Jim Yauger;

William E. Jamerson Professor: Walid Thabet;

Graduate Contact: renee.ryan@vt.edu

Building Construction: <http://www.bc.vt.edu/degrees>

The Building Construction curriculum prepares students with the professional capabilities to critically address the present and evolving needs of the construction industry. The Masters of Building Construction Science and Management degree offers the opportunity for advanced study and research in specialized areas related to building design, construction, and operations over a broad range of scales, providing the basis for diverse career paths and/or entry into a Ph.D. level program. While an undergraduate degree in these or related fields is not required, applicants must demonstrate relevant background and professional experience. They must also demonstrate the capability for undertaking advanced academic study. The Environmental Design and Planning doctorate degree requires a total of 90 credit hours of combined core courses and research credits.

SPECIAL FACILITIES

The Department of Building Construction resides in Bishop-Favrao Hall. This is a new 31,600 GSF laboratory facility adjacent to Cowgill Hall. The building houses the department's administrative and faculty offices, provides classroom space and seminar rooms/studios, as well as laboratory spaces.

Bishop-Favrao Hall

Bishop-Favrao Hall serves the facility needs of the Department of Building Construction and the Myers-Lawson School of Construction. The building houses administrative and faculty offices and provides classroom space, seminar rooms, labs, and studios. The building itself was designed to be a teaching tool. The structural elements that are usually hidden behind walls and ceiling panels in other buildings are exposed and labeled. That means students can clearly see the structures they are studying in use. All public spaces and all offices have exposed ceilings to allow students and visitors to see the mechanical, electrical, plumbing, fire protection, and electrical systems. This building is made possible by numerous Building Construction alumni and friends, many of whom are noted on the donor wall located in the second floor lobby and on plaques around the building. The building is named after Richard Bishop and William A. Favrao. Address: 1365 Perry St. | Map Grid: K-3 Originally Built: 2007 | Abbreviation: BFH

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (620.0)

Computer: (260.0)

iBT: (105.0)

The Masters of Science in Building Construction Science and Management program consists of 32 credit hours of required courses including 14 credits of common core courses. Up to 21 hours of supporting coursework may be required by applicants with non-construction background. The specific courses required are determined by educational background and work experience. Students will be notified of supporting course requirements by the Department of Building Construction along with the notification of admission. GRE Requirements: GRE is required from all international applicants and may be required for domestic applicants based on background and education. Students who would like to be considered for fellowships and other financial assistance should take the Graduate Record Exam and submit scores as part of the application. Application Deadlines All required documents must be received in the Graduate School by the BC Department's application deadline in order for the application to be complete. The Master of Science in Building Construction Science & Management (MS-BCSM) program accepts applications for fall terms only. (Military can request a spring start.) International Students: Application Deadline for M.S. applicants is December 15th. The decision deadline is February 15th. Domestic Students: Application Deadline for M.S. applicants is January 15th. The decision deadline is March 1st.

GRADUATE COURSES (BC)

BC 5024:

Cost Management of the Building Process

A study of cost management procedures applicable to the building process from concept through owner operations. Cost considerations in the decision process, concepts for monitoring and controlling costs, and the determination of accountability are examined.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ISE 2014 (UG), ISE 4006 (UG)) OR (CEE 3014 (UG))

OR (ISE 2014, ISE 4006) OR (CEE 3014)

Corequisite(s):

BC 5044:

International Construction Practices

This course contrasts aspects of the US construction industry with similar yet fundamentally different operating procedures utilized within the international construction community. Areas of concentration include participant organization and culture, project delivery methods, multi-national teams and unique operational and management activities essential in the international market. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5064:

Innovation in Construction

An introduction to the role of innovation in the construction industry, including the explanation of theories within the realm of innovation, diffusion, adoption, new product development, supply chain management, sustainability, information technology and commercialization. The course emphasizes application of these theories to construction industry innovation through the development and administration of a survey instrument and interviews that culminating in a case study of best practice for innovation development. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5084:

Methods Const Research

Means and methods of research in supporting the definition and selection of an exit option for a course of study. Investigation of problem and scope definitions, literature reviews, research methodologies, data collection and analysis methods. Proposal development peer evaluation and investigation of contemporary issues in the construction industry.

Graduate Standing Required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5104:

Integrated Constr Ldshp Studio

Application of principles involving organized leadership within business and construction practices as they relate to the operation of a construction company and the execution of a capstone project. Project management concepts and principles are learned prior to their application in this integrated studio experience. Written and oral work is

and industry professionals.

Credit Hour(s): 2

Lecture Hour(s): 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CNST 5004, CNST 5114

Corequisite(s): CNST 5014

BC 5124:

Land Development for Constructed Facilities

This course covers how to get a piece of undeveloped Real-estate from idea to the finished product. It discusses the construction management interface between Site Engineering and Real-estate Marketing. Topics covered include: market influences, working with regulatory agencies, zoning, economic considerations, developing an optimum plan, cost and schedule, engineering requirements, environmental impact, financing, and delivering a final product. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): BC 2014 (UG) OR BC 2014

Corequisite(s):

BC 5134:

Sustainable Facility Systems

Introduction to means, methods, and analytical practices associated with sustainability in the built environment. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and efficiency, green building materials, and indoor environmental quality. Analytical methods include green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and evaluation for innovation and organizational change. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5144:

Sustainable Infrastructure Systems

Relevant issues and state of the art technologies for sustainable civil infrastructure systems, including energy generation, water supply and treatment, wastewater systems, solid waste systems, and

transportation/mobility systems. Analytical methods include development-scale sustainability assessment tools and methods; green materials performance assessment and evaluation; economic analysis of system alternatives; demand assessment/optimization; and conceptual design approaches for different system types. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

BC 5184:

Temporary Structures

Introduction to the analysis, design, and selection of various temporary support structures needed in construction of building projects. Topics covered include excavation and temporary support methods, underpinning methods, dewatering systems, concrete formwork systems: selection, analysis/design, and construction. Due consideration is given to unconventional construction methods and placement techniques. Pre: senior status and instructor's approval or graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5304:

Principles of Construction Law and Project Delivery Systems

The course deals with the numerous ways in which the legal system affects or controls the construction process. Course topics include contract law, the relationships between the parties to the construction process, tort and negligence law, and statutory principles affecting construction. The major emphasis is on the principal contract relationships (Owner-Contractor, Contractor-Subcontractor, Owner-Architect/Engineer), and the problems and disputes that most typically arise out of these relationships. The course also explores innovations in project delivery systems such as design-build and CM at-risk. Graduate standing is required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5314 (CNST 5314):

Applied Building Sciences

Fundamentals of building physics and other sciences dealing with the built environment, scientific means and methods for evaluating and simulating building performance in various contexts, emphasis is put on thermal, hygrothermal (moisture and mold), lighting, daylighting, acoustic performance - all performance topics are evaluated over the life cycle of a building and their impact on sustainability. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5354:

Integration of Design, Construction, and Manufacturing I

Introduction to the principles of integrated design, construction, and manufacturing, and design development process within advanced digital environments, construction automation and Building Information Modeling (BIM). Parametric modeling, assembly modeling, interference checking, rule-based design, within the context of advanced solid and surface modeling tools. Resource charges required. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BC 5364:

Integration of Design, Construction, and Manufacturing II

The principles of integrated design, construction, and manufacturing for construction automation. Introduction to the fundamentals of CAD/CAM, real-time data capturing, and robotics. Overview of computer-numerically-controlled machines, basic manufacturing processes and prototyping techniques. Case study specifics in design, construction, and manufacturing. Resource charges required. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): BC 5354

Corequisite(s):

BC 5514:

Principles and Practices of Construction I

Using a case study approach coupled with several term projects to achieve its objectives, this course covers the principles and practices of construction means and methods for CSI divisions 1-6 with emphasis on concrete, masonry, and steel construction. The course also integrates topics in project management, including project contract types and delivery methods, bonds and insurance, conceptual and detailed cost estimating methods, planning and scheduling techniques, and resource/cost scheduling. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BC 5524:

Principles and Practices of Construction II

Using a case study approach with various term projects, this course builds on concepts covered in BC 5514, focusing on the principles and practices of construction means and methods for CSI divisions 7-13. Emphasis is given to finishing works, thermal and moisture protection procedures, curtain wall construction, and special construction methods. The course integrates advanced topics in project management including schedule updating techniques, resource and cost tracking and control tools, and linear scheduling.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BC 5514 OR BC 55514 (UG)

Corequisite(s):

BC 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BC 5974:

Independent Study

451 Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

BC 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

BC 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

BC 6014:

Project and Company Management

Study of the management of a construction project and a construction company. Project management includes finances, cash flows, cost control, project organization, and project planning. Company management includes company organization incorporation structure, procedures, finance, insurances, accounting, and operation. Case studies are emphasized. II

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): BC 5014
Corequisite(s):

BC 6064:

Research Seminar: Past, Present, and Future of Construction

This course will look at an historical perspective of construction and how the Architecture, Engineering, and Construction (AEC) industry has evolved to where it is today. The course will look at the key elements that have affected these changes, including the evolutionary/evolving roles of the participants of the entire AEC industry. Topics will include the means, methods and contracts from 1945 to today. Topics of

discussion will include: risk, contracts, project & production management, labor, leadership, automation, industrialization and IT.
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

BC 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ENVIRONMENTAL DESIGN AND PLANNING

Yvan Beliveau, Head

Professors: Yvan Beliveau; Walid Thabet;

Associate Professors: Andrew McCoy; Thomas Mills; Annie Pearce; Georg Reichard;

Assistant Professors: Muhsine Turkaslan Bulbul;

Visiting Faculty: David Goldsmith; Jim Yauger;

William E. Jamerson Professor: Walid Thabet;

Graduate Contact: renee.ryan@vt.edu

Graduate Site: <http://www.bc.vt.edu/degrees/graduates>

The Environmental Design and Planning (EDP) program at the College of Architecture and Urban Studies at Virginia Tech serves doctoral students interested in pursuing degrees relating to the construction of buildings, building science, and construction management. Degree requirements have been structured so those graduate students with construction or construction-related background, experience, or higher education, may obtain an advanced degree in construction. A minimum of 90 credit hours is required with a minimum of 42 hours of core coursework/research

SPECIAL FACILITIES

Bishop-Favrao Hall is a 31,600 GSF laboratory facility adjacent to Cowgill Hall. The Department of Building Construction and the Myers-Lawson School of Construction occupy the building. The building houses the department of Building Construction's administrative and faculty offices, and provides classroom space, seminar rooms, and studios. The new facility also provides state-of-the-art laboratory spaces, include testing labs, wet labs, material handling, tool labs, and workshops for

assembly of construction systems.

Bishop-Favrao Hall

Bishop-Favrao Hall was designed to be a teaching tool. The structural elements that are usually hidden behind walls and ceiling panels in other buildings are exposed and labeled. That means students can clearly see the structures they are studying in use. All public spaces and all offices have exposed ceilings to allow students and visitors to see the mechanical, electrical, plumbing, fire protection, and electrical systems. This building is made possible by numerous Building Construction alumni and friends, many of whom are noted on the donor wall located in the second floor lobby and on plaques around the building. The building is named after Richard Bishop and William A. Favrao. Address: 1365 Perry St. | Map Grid: K-3Originally Built: 2007 | Abbreviation: BFH

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (620.0)

Computer: (260.0)

iBT: (105.0)

GRE

General Test: Verbal, Quantitative, Analytical

The Environmental Design and Planning (EDP) program at the College of Architecture and Urban Studies at Virginia Tech serves doctoral students interested in pursuing degrees relating to the construction of buildings, building science, and construction management. Degree requirements have been structured so those graduate students with construction or construction-related background, experience, or higher education, may obtain an advanced degree in construction. A minimum of 90 credit hours is required with a minimum of 42 hours of core coursework/research. GRE Requirements: GRE is required from all international applicants and may be required for domestic applicants based on background and education. All students, both international and domestic, who would like to be considered for fellowships and other financial assistance should take the Graduate Record Exam and submit scores as part of the application. Application Deadlines All required documents must be received in the Graduate School by the BC Department's application deadline in order for the application to be complete. International Students: Application Deadline for PhD applicants is December 15th. The decision deadline is February 15th. Domestic Students: Application Deadline for PhD applicants is January 15th. The decision deadline is March 1st.

GRADUATE COURSES (EDP)

EDP 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

EDP 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDP 6005:

Seminar in Environmental Design & Planning

Historical context for, and nature of, research in fields encompassed by environmental design and planning; theoretical underpinnings and methodological approaches; current research directions; and selected case studies of research projects. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDP 6006:

Seminar in Environmental Design & Planning

Historical context for, and nature of, research in fields encompassed by environmental design and planning; theoretical underpinnings and methodological approaches; current research directions; and selected case studies of research projects. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDP 6104:

Planning Theory Seminar

A doctoral-level seminar that traces the epistemology of major contemporary theories of planning so as to situate the activity of modern

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5104 (UG) OR UAP 5174 (UG) OR UAP 5414 (UG) OR UAP 5104 OR UAP 5174 OR UAP 5414

Corequisite(s):

EDP 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

EDP 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

LANDSCAPE ARCHITECTURE

Brian Katen, Program Director

Emeriti Faculty: Benjamin Johnson;

Professors: Patrick Miller;

Associate Professors: Dean Bork; Terry Clements; Wendy Jacobson; Brian Katen; Paul Kelsch; Mintai Kim; Laurel McSherry;

Assistant Professors: Cermetrius Bohannon; Nathan Heavers;

Adjunct Professors: Sarah Couchman; Michael Ezban; Douglas Hays; David Hill; Rebecca May; David McGill;

Director of NCR MLA Program: Laurel McSherry;

Graduate Program Director: mintkim@vt.edu

Grad. Director Northern VA: lm@vt.edu

Program Administrator: tphipp@vt.edu

Master's in Landscape Architecture: http://archdesign.vt.edu/landscape-architecture/master_of_landscape_architecture

National Capital Region NCR: <http://archdesign.vt.edu/programs/waac>

Landscape Architecture Program News and Information:

<http://www.lar.archdesign.vt.edu/>

Ph.D. in Architecture and Design Research:

<http://archdesign.vt.edu/architecture-design/phd>

Program Information: Graduate Study: Master's in Landscape Architecture, Ph.D. in Architecture and Design Research. See: http://archdesign.vt.edu/landscape-architecture/master_of_landscape_architecture The Landscape Architecture Program at Virginia Tech is committed to discovering, developing, and disseminating knowledge related to the discipline and profession of landscape architecture. Our educational approach stresses discovery-based learning and research, wherein students assume a significant level of responsibility for directing and pursuing their own education and the development of their plan of study. Students and faculty work together to achieve the highest standards of disciplinary and professional preparedness and to develop the capacity for lifelong learning and professional leadership. The Landscape Architecture Program offers three master's degree programs and a Ph.D. Program to meet the diverse needs of prospective students: * Three-year First-Professional Master of Landscape Architecture (NCR/MLA) offered at National Capital Region (NCR) Campus * One and two-year advanced Master of Landscape Architecture (MLA) offered at Blacksburg * Ph.D. in Architecture and Design Research focused on Landscape Architecture offered at Blacksburg and NCR Our first-professional graduate degree program (NCR/MLA) is fully accredited by the Landscape Architecture Accreditation Board and enables students to become professional landscape architects. Course work in the program provides both a foundation of professional entry-level skills and a level of professional mastery necessary to sustain a successful career, respond effectively to the rapid changes within the profession, and provide leadership to the profession's next generation of practitioners. The advanced MLA and Ph.D. programs are designed for individuals who already hold a professional design degree in landscape architecture or architecture and wish to pursue advanced studies in a particular aspect or research area of the discipline. Students in the Advanced Master's Program build on their professional skills and develop a research and scholarly agenda within an area of focused scholarship.

SPECIAL FACILITIES

Facilities The Land Design & Simulation Lab The Land Design and Simulation Lab conducts studies of the environmental impacts of proposed land alternations and proposes measures that can be implemented to mitigate adverse impacts. Community Design Assistance Center The Community Design Assistance Center assists communities, neighborhood groups, and non-profit organizations in improving the natural and built environments through design, planning, policy and research. See: <http://cdac.arch.vt.edu/>

DEGREES OFFERED

MLA Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

The Landscape Architecture Program offers three tracks for pursuing a master of landscape architecture degree, depending on the student's academic and professional experience. They are: the Three-year First-Professional Master of Landscape Architecture offered at National Capital Region Campus (NCR/MLA), the Advanced MLA (2-Year post professional degree, Blacksburg Campus) and the 1 Year Plus Thesis advanced standing based on professional experience MLA offered at Blacksburg Campus. Each of these are described in more detail below.

Three-year First-Professional Master's (NCR/MLA): The Master of Landscape Architecture Program (NCR/MLA) is an accredited three-year professional degree designed for individuals who have completed the bachelor's degree in a field other than landscape architecture. The program offers a studio-based curriculum integrating design, ecology, fabrication, and representation. Emphasis is given to developing mastery of design through a series of design studios that investigate a range of landscape scales from sites to regions. The program seeks applicants whose academic and professional interests focus on the civic landscape. The NCR/MLA program is offered through the Washington + Alexandria Architecture Center (WAAC) in Old Town Alexandria, which operates as the metropolitan extension of the College of Architecture and Urban Studies (CAUS) in Blacksburg. Established in 1998, the program's location within the National Capital Region enables interdisciplinary collaboration with architecture, natural resources, and urban planning programs and contact with myriad public and private cultural and artistic institutions (e.g. American Society of Landscape Architects, the National Building Museum, the American Institute of Architects, the Library of Congress, and the museums of the Smithsonian Institution). Individuals are admitted to the Master of Landscape Architecture Program on a competitive basis. Applicants, who have completed a four-year baccalaureate degree or its equivalent, are eligible for admission. Applications are reviewed by a faculty committee and evaluated on the basis of previous academic performance, relevant experience, and evidence of potential to successfully pursue graduate-level work in landscape architecture. Preference is given to candidates with high academic standing and whose record reflects a balanced undergraduate education in the arts, sciences, and humanities. Although our students have varied educational backgrounds and experience, college-level courses in the natural sciences, ecology, and the visual arts (e.g., drawing, sculpture, printmaking, and/or basic design) are strongly recommended. Applicants with previous education in design, a professional undergraduate degree in architecture, or who have substantial equivalent coursework in landscape architecture, environmental design or landscape design may be eligible for admission with advanced standing, subject to the review of the admissions committee. A transcript review will be conducted for applicants seeking advanced standing. Admitted candidates will be recommended for the Master of Landscape Architecture professional degree upon satisfactory completion of a minimum of 75 credit hours (25 credits hours of Foundation Studies plus a minimum of 50 credit hours of MLA Studies) and a thesis. Foundation Studies prepare students to perform at the graduate level and include introductory course work in history, theory, design, technique, and natural systems. MLA studies includes a sequence of required studios, core coursework, and directed electives. Studios introduce the thematic interests of the faculty and highlight different approaches to design with respect to inquiry and process. Directed electives, which support the development of a particular area of mastery, may be taken from various areas of study including but not limited to landscape architecture, architecture, visual arts, natural resources, and urban affairs and planning. Graduate Studies culminates with a design thesis directed by a major professor. See: http://archdesign.vt.edu/master-of-landscape-architecture-program-information/3year_first_professional_mla_ncr_mla_program

Advanced MLA (2-Year post professional degree, Blacksburg Campus): The

Advanced MLA Program is tailored for students who already hold a first professional-degree in landscape architecture or architecture. The Advanced MLA Program is dedicated to the advancement of knowledge and to our understanding of landscape architecture within three "focus study areas" of faculty expertise: Community and Place, Ecological Design, and Design Learning. The focus study areas are intended to differentiate advanced graduate study at Virginia Tech from that at other universities. Each student in the two-year, advanced, MLA Program works in consultation with a major professor to craft an individualized graduate plan of study within a specific area of focus research. The plan of study includes both general landscape architecture courses and coursework pertaining to an area of research focus. The graduate plan of study typically includes at least 50 credit hours. Ten of these hours are devoted to a capstone Thesis that addresses a specific issue or question within the student's selected area of focused research. A studio-based two-year post-professional degree is available at the National Capital Region (NCR) campus for students who already hold a first-professional degree in landscape architecture or architecture. See: http://archdesign.vt.edu/master-of-landscape-architecture-program-information/mla_program_2year_advanced_mla

1 Year Plus Thesis MLA offered at Blacksburg Campus: The 1 Year Plus Thesis MLA Program is an accelerated scholastic degree designed for students who have both a professional degree in landscape architecture and considerable practical experience. The program is designed to allow seasoned practitioners an opportunity to earn an advanced degree by completing focused studies in an individually tailored program. See: http://archdesign.vt.edu/master-of-landscape-architecture-program-information/1year_plus_thesis_mla

Dual Degree Program: The simultaneous Master of Landscape Architecture/Master of Urban and Regional Planning (MLA/MURP) is available to students in the MLA Program. **MLA/MURP Dual Degree:** The MLA/MURP Degree Program features the effective coordination of course requirements in two fields that assures the integrity of each while also saving time and cost to the student. This coordination may consist in the effective sharing of electives and/or the substitution of significantly relevant courses from another field. The MLA/MURP Degree Program recognizes the fundamental linkage between planning and design of the natural environment as impacted by humans. Flexibility through individualized plans of study is accorded students seeking simultaneous degrees based on their backgrounds and needs reflected through individualized plans of study. Dual degree students must be admitted to both programs following the admissions procedures in each. Students may apply for admission to both programs before enrolling in either, or they may apply after first being admitted to and enrolling in one. In the latter case, application to the second program should be made before half the coursework in the first has been completed. A capstone product is required of each program. The capstone product may bridge the fields of each degree. See http://archdesign.vt.edu/landscape-architecture/dual_degrees

Study Abroad: With the approval of their major professor, students in the graduate program may take for elective credit the Landscape Architecture Program's Summer Travel Abroad Studio or attend universities with whom the College of Architecture and Urban Studies has cooperative agreements.

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

Ph.D. in Architecture and Design Research offered at Blacksburg and National Capital Region (NCR) Campus : Students pursue Ph.D. level studies in landscape architecture through the School of Architecture + Design's "Design Research" track of the Ph.D. program in Architecture and Design Research. Typically, students entering the Ph.D. program wish to pursue an academic career. See <http://archdesign.vt.edu/architecture-design/phd>.

GRADUATE COURSES (LAR)

LAR 5004G:

ADV Hist Theory Landscape Arch

Theoretical and practical developments in landscape architecture and related arts through investigation and analysis of design theory and philosophy, and built form. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5005:

Graduate Landscape Architecture Design Laboratory

Graduate landscape architecture laboratory addressing complex issues of landscape design and planning. The scope of planning and design includes the relationship of specific sites to their larger urban and/or regional contexts. Pre: undergraduate degree in landscape architecture or related field, or permission of instructor.

Credit Hour(s): 0 OR 5

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): LAR 4705, LAR 4706

Corequisite(s):

LAR 5006:

Graduate Landscape Architecture Design Laboratory

Graduate landscape architecture laboratory addressing complex issues of landscape design and planning. The scope of planning and design includes the relationship of specific sites to their larger urban and/or regional contexts. Pre: undergraduate degree in landscape architecture or related field, or permission of instructor.

Credit Hour(s): 0 OR 5

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): LAR 4705, LAR 4706

Corequisite(s):

LAR 5034G:

Advanced Evolution of the American Landscape

An examination of physical change in the rural and urban landscape of America as reflected by changes in needs during the country's history.

Some of the factors influencing the character, form and use of American space that will be studied are economic growth, changing philosophies on conservation and exploitation of natural resources and their resulting legislation, technological advancement and social reform. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5044:

Land Analysis and Site Planning

Introduction to the concepts and methods of ecological resource survey and analysis at regional and site scales. Approaches to environmental problem solving with an emphasis on data collection, evaluation, and synthesis using applicable technologies such as geographic information systems. Interpretation of landscape resource data for the purpose of physical planning and design. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): LAR 3004

Corequisite(s):

LAR 5164:

TECT LAR I: Topo & Grading

Introduction to landscape architecture technology, focusing on the fundamentals of cartography, topography, grading, and landform manipulation. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5234G:**Advanced Theory and Practice of Urban Design**

Historic and contemporary trends in urban design theory and practice; methods of analyzing urban form; social, cultural, and environmental dimensions of urban design. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5244G:**Advanced Landscape Architecture Technology - Hydrology**

Examines water resource issues related to landscape planning, site planning and site design. Watershed planning, watershed sensitive site design, estimation of storm water runoff, rainwater conservation, storm water management impact mitigation, design of open channel conveyances, and erosion and sedimentation control. Graduate standing required.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): LAR 2035 (UG) OR LAR 2035, LAR 2036 (UG) OR

LAR 2036

Corequisite(s):

LAR 5254:**Landscape Arch Theories**

Critical examination of theories relevant to landscape architectural design and the inter-relationship among theory, practice, and research with special emphasis on contemporary theories. Evolution of theory with respect to built works. Overview of concurrent design theories and philosophies in the related arts. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5264:**TECT LAR II: Site & Process**

Links landscape architectural site design with environmental and construction processes. Conceptual site designs are developed through the production of documents for layout and grading of sites, stormwater

management, and design and management of vegetative processes.

Technical practices are framed within larger discourses of site conceptualization and representation.

Credit Hour(s): 3

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): LAR 5164

Corequisite(s):

LAR 5304G:**ADV Topics in Landscape Arch**

Complex 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. Repeatable for a maximum of 9 credits. Pre-Requisite: Graduate Standing Required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5314:**Research Topics in LAR**

Range and types of contemporary research within landscape architecture. Emphasis on literature, theories, methods, and case studies used in selected focused research areas. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5324G:**Advanced Landscape Architecture Technology III - Construction Documents**

This course links landscape architectural design and construction processes through the production of construction documents for a designed landscape. 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. Graduate standing

required.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

LAR 5334:

Landscape Architecture History

Historical development of landscape architecture with emphasis on western culture from Ancient Greece through the 20th Century. Emphasis on design theories, relationships between society and nature, conception of landscape by different social groups, and relationships between site design and urban design. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5344:

Scholarship of Place

Theory and scholarly methods related to sense of place in landscape. Overview of theoretical literature and research on sense of place. Concepts and ideas of place-making in built works. Balancing human needs and environmental concerns while providing characteristics and qualities that impact sense of place. Development practices that lead to placelessness and jeopardize the integrity of our cultural environment. Scholarly methods in place research. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5364:

TECT LAR III: Material Constr

Links landscape architectural design, engineering, materials, and construction processes. Construction materials and assembly techniques. Preparation of landscape architectural drawings and specification. Methods of documentation are also covered, including conventional and digital communication technologies.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): LAR 5264

Corequisite(s):

LAR 5624:

Urban Design Seminar

Current topics in urban design. Topics may include: theoretical, conceptual and practical concerns in the generation of urban spatial form; the roles of public and private interests in shaping urban form; the effects of urban intensification on the quality of public spaces; environmental issues in urban design; the role of public policy and regulatory mechanisms; the genesis and development of urban typologies. Each seminar will address one of these or related subject areas. Course may be repeated with a different subject for a maximum of 12 credits. I,II.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5644:

Comparative Urbanism Seminar

Explores current issues, situations, and developments in diverse urban settlements across cultures. Direct experience of selected cities will be supported by contemporary and historic readings, maps and drawings to illuminate differential technological, environmental, economic, social and cultural forces shaping subject cities. Research methods applicable to urban design will be discussed. Choice of cities and areas of focus will be determined by students based on their thesis research proposals.

Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 5614

Corequisite(s):

LAR 5704:

Advanced Landscape Design and Planning Lab

Studio addressing advanced problems in landscape design and planning. I

Credit Hour(s): 0 OR 5

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): LAR 5006

Corequisite(s):

LAR 5724:

Scholarship in Landscape Architecture

An overview of scholarship in landscape architecture with emphasis on research approaches and methods pertaining to the advancement of knowledge in the profession. Application of ideas through the completion of a preliminary research project. Pre: Familiarity with landscape architecture or a closely allied environmental planning/design discipline.

Non-majors by consent of instructor. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture, Online Lecture

Instruction Type(s): Lab, Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

LAR 5754:

Thesis Studio

Thesis studio is an alternative to the conventional academic thesis for students pursuing a master's degree in landscape architecture. Thesis studio involves literature review, composition of a position paper grounded in design or planning theory and completion of studio projects(s) that test or demonstrate the theoretical position. I, II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 0 TO 19

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

LAR 5774:

Advanced Graduate Design Lab

Advanced graduate landscape architecture studio addressing complex issues of landscape design and planning related to student focused research areas. Literature review grounded in design or planning theory. Completion of studio project(s) that tes or demonstrate the design resolution of problems in the student's research area.

Credit Hour(s): 6

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): LAR 5314

Corequisite(s):

LAR 5964:

Landscape Architecture Field Studies

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

LAR 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

LAR 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 9

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

LAR 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PLANNING, GOVERNANCE, AND GLOBALIZATION

Anne Khademian, Head

Emeriti Faculty: James Bohland; Larkin Dudley; Benjamin Johnson; John Randolph; Richard Rich; James Wolf;

Professors: John Browder; Brian Cook; Wilma Dunaway; Sonia Hirt; Anne

Joel Peters; Joyce Rothschild; Thomas Sanchez; Max Stephenson; Gerard Toal; Edward Weisband;

Associate Professors: Dean Bork; Ralph Buehler; Terry Clements; Giselle Datz; Matthew Dull; Wendy Jacobson; Laura Jensen; Mintai Kim; Joseph Rees; Patrick Roberts; Ioannis Stivachtis; Kris Wernstedt; Diane Zahm;

Assistant Professors: Ariel Ahram; Margaret Cowell; Adam Eckerd; Ralph Hall; Steven Hankey; Sara Jordan; Robin Lemaire; Shalini Misra; Patricia Nickel; Jocelyn Widmer; Yang Zhang;

University Distinguished Professor: Paul Knox; Timothy Luke;

Edward S. Diggs Professor in the Social Studies: Edward Weisband;

School of Public & International Affairs: spia@vt.edu

Planning, Governance, & Globalization: <http://www.spia.vt.edu/pgg>

Student Handbook: <http://www.spia.vt.edu/pgg/handbook>

The Ph.D program in Planning, Governance and Globalization is one of two Ph.D. programs available in the School of Public and International Affairs (SPIA), the other being the Ph.D. in Public Administration. The Ph.D. in PGG attracts students with widely differing backgrounds and interests. In order to accommodate this diversity, curriculum requirements are defined in two tracks with several thematic areas. These are: Urban & Environmental Design & Planning Track Thematic Areas: Metropolitan Development Community & Economic Development Planning International Development Planning Landscape/Environmental Planning & Landscape Analysis Transportation Planning Physical Planning & Urban Design Governance & Globalization Track Thematic Areas: Governance, Institutions, & Civil Society Globalization, Identities, Security, & Economies

SPECIAL FACILITIES

PGG Studio The PGG studio is an open office space exclusive to the PGG students. Located in the Media Annex, next door to the Architecture Annex, this space has individual desks, lounge area, kitchen area, and computer space for student access. So far, students use the studio area in different ways: some spend most of their working time at their desks in the studio; some stop by a few hours every day to check their emails and to work between classes; and others never use the studio choosing to work at their homes or in their departments. SPIA faculty direct two University-wide centers and institutes (VCHR and IPG) and one College institute (MI). The Institute for Policy and Governance (IPG) facilitates and provides leadership in Virginia Tech's outreach mission to organizations in the Commonwealth's public and non-profit sectors, as well as national and international agencies. The Institute works with existing public service, extension, and outreach programs to respond effectively to existing demands on their services. The Institute identifies new opportunities for outreach, extension, and supporting research pertaining to administration, management, planning, and policy analysis related to public and non-profit organizations. The Metropolitan Institute (MI) conducts basic and applied research on national and international development patterns, focusing on key forces shaping metropolitan growth such as demographics, environment, technology, design, transportation, and governance. It seeks to expand knowledge in urban and metropolitan affairs in order to improve policy and practice, and educate the general public on important issues facing communities. The Virginia Center for Housing Research (VCHR) has a mission to serve as "an interdisciplinary study, research, and information resource on housing for the Commonwealth of Virginia." Consulting on

housing issues with the General Assembly, federal, state and local agencies, nonprofit organizations, private industry, and other colleges and universities, the Center also plays a role in the state's housing policy and research network. The Center provides data services related to housing to local and state governments, nonprofit organizations, and for-profit businesses. The Land Design and Simulation Lab conducts studies of the environmental impacts of proposed land alternations and proposes measures that can be implemented to mitigate adverse impacts.

DEGREES OFFERED

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (600.0)

Computer: (250.0)

iBT: (100.0)

GRE

General: Verbal, Quantitative

Each doctoral student must complete a minimum of 90 semester hours of graduate study and a dissertation. All students are required to fulfill the requirements for their track or specialization and those of the Graduate School. The curriculum of this doctoral program will follow a flexible research-based program by requiring a small core of courses and by offering two major tracks, as well as thematic areas under each track. By the end of their first 24 credit hours in the program all students will be expected to have: (1) developed a plan of study; (2) selected a faculty advisory committee of a minimum four members; and (3) completed a "qualifying examination" by their faculty advisory committee. The qualifying examination ensures that the student is making satisfactory progress toward the degree. Governance & Globalization Track Requirements The following courses can be used to meet the 9-hour, 3 course core requirements: Accordingly, all students would take 12 credit hours of common core courses (all existing): Pedagogy: SPIA 6006 Theory: 1 course, 3 credits. Satisfied by completion of SPIA 6104 Planning Theory Seminar, GIA/UAP 5524 (Critical Perspectives on Development & Globalization), GIA/UAP 5004 (Power and Policy in the U.S.), EDP 6005 (Seminar in Epistemology), GIA/PSCI 5214/5224 (Contemporary/Alternative Political Theory), or equivalents. Methods: Research design and quantitative and/or qualitative methods, 2 courses, 6 credits. Satisfied by successful completion of UAP 5484/GIA 5464 (Advanced Research Methodology), UAP 5494 (Advanced Quantitative Techniques), GIA 5504 Discourse Analysis, GIA/PSCI 5115/5116, or equivalents. Research (30 credits): GIA/UAP 7994 Research and Dissertation. In addition, the Governance & Globalization track requires proficiency in a foreign language for scholarly purposes as a research tool. Each student will work with her or his doctoral coordinating committee to develop a strategy for fulfilling this requirement. Urban & Environmental Design & Planning Track Requirements Students must have preparation in the diverse theoretical literatures that define the field and in both quantitative/analytic and qualitative/field research methods, as well as training in research design. Accordingly, all students would take 12 credit hours of common core courses (all existing): SPIA 6006 SPIA 6104 Planning Theory Seminar - 3 credits. Planning epistemology and theory. This seminar traces the epistemology of major contemporary theories of planning so as to situate the activity of modern planning in historical and intellectual contexts. Research design and quantitative

and/or qualitative methods, 6 credits. Satisfied by successful completion of UAP 5484 (Research Methodology - 3 credits) and UAP 5494 (Advanced Quantitative Techniques - 3 credits), or equivalents. Research (30 credits): GIA/UAP 7994 Research and Dissertation. In addition, proficiency in a foreign language is required if appropriate to student's dissertation in the UEDP track. Students pursuing thematic areas Landscape/Environmental Planning and Landscape Analysis will be required to complete two additional core courses, although these may be waived if students have already taken equivalent courses successfully. LAR 5314 -Contemporary Research Topics (3 credits) LAR 5344 -Scholarship of Place (3 credits) Following successful completion of the "qualifying evaluation" the student continues to take coursework as outlined in the plan of study. At the completion of coursework, the student will undertake the "preliminary examination", a formal assessment of the student's preparedness to pursue advanced graduate research. Within 60 days of passage of the preliminary examination, students must defend the dissertation proposal before his or her faculty advisory committee. Upon completion of the dissertation, the student must defend it before the committee. Graduate School policies and guidelines determine all other degree requirements.

PUBLIC ADMINISTRATION AND PUBLIC AFFAIRS

Karen Hult, Chair

Emeriti Faculty: Larkin Dudley; Charles Goodsell; Philip Kronenberg; Gary Wamsley;

Professors: Brian Cook; Karen Hult; Anne Khademian;

Associate Professors: Matthew Dull; Laura Jensen; Joseph Rees; Patrick Roberts;

Assistant Professors: Adam Eckerd; Sara Jordan; Robin Lemaire;

Visiting Faculty: Beth Offenbacher;

Adjunct Professors: Jonah Fogel;

Professor of Practice: Bruce Lawlor; Charles Stripling;

General Contact: cpap.vt@gmail.com

Graduate Contact: cpap.vt@gmail.com

Center for Public Administration and Policy: <http://www.cpap.vt.edu/>

The Center for Public Administration and Policy (CPAP) promotes the common good of our constitutional republic and the advancement of public service by providing outstanding education, research, and outreach in the theory and practice of public administration, management, and policy. Our goals are to: Provide qualified public administrators currently in service, and early-career students who intend to become public administrators, with challenging applied and theoretical professional development opportunities in public management and public policy. Prepare teachers and scholars for faculty service in colleges and universities around the country and the world who will educate citizens and administrators and broaden the scope of knowledge in public administration and policy studies. Engage faculty, practitioners, and graduate students in systematic research and study designed to improve the quality of policy making and public service within the diverse jurisdictions of government in the Commonwealth of Virginia and the region, and on the Federal, state, and local levels of

government in the United States and internationally. The Master of Public Administration (MPA) is a professional degree intended for present and future practitioners. Its purpose is to educate early career individuals for administrative and analytical posts and to improve the skills of in-career public administrators. International students should note that a substantial portion of the M.P.A. program's subject matter focuses primarily upon public administration, management, and policy in the United States. The Doctor of Philosophy (Ph.D.) is the academy's highest degree and prepares students for research and scholarship, whether or not in affiliation with a university. CPAP offers the Ph.D. in Public Administration and Public Affairs to both full-time and part-time students. Many of our students are mid-career professionals who have reached a point in their career development at which they can commit the time and energy necessary to earn a doctorate. Qualified individuals just beginning their careers are also most welcome. A master's degree in a relevant field (not necessarily public administration or public policy) ordinarily is required for admission, but this requirement may be waived in exceptional cases. Those earning the M.P.A. from CPAP may apply for admission to the Ph.D. program as the end of their work toward the M.P.A. draws near.

SPECIAL FACILITIES

Beyond the main campus, CPAP offers students opportunities to earn the M.P.A. and/or the Ph.D. in the rich learning environments of Old Town Alexandria, VA (adjacent to Washington, DC) and Richmond, VA, the state capital.

Thomas-Conner House

Situated just off the main Virginia Tech campus in downtown Blacksburg, VA, the historic, Thomas-Conner House is CPAP's headquarters and home to a thriving academic community for MPA and PhD students.

DEGREES OFFERED

PhD Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

LSAT

MAT

GMAT

A minimum of 90 credit hours is needed for the Ph.D. in Public Administration and Public Affairs. A maximum of one half of the coursework required for the CPAP Ph.D., or 30 of 60 credit hours, may be transferred from an accredited university other than Virginia Tech upon approval by two core faculty evaluating the student's program of study. The 60 credit hours of required coursework encompasses foundation courses, advanced topics and capstone courses, measurement courses, and research concentration courses. Students must also take 30 hours of research and dissertation credit, three hours of which must be constituted by participation in 15 sessions of the Doctoral Mentoring Program (DMP) or other activities approved by the faculty of DMP credit. Entering students must have completed courses in

United States Government, Micro-economics, and Introductory Statistics with a grade of C+ or better. Students without all prerequisites completed must complete the missing prerequisites as soon as possible and before enrolling in PAPA 6224. We require all PhD applicants to submit scores from one of the following graduate admissions tests: GRE, GMAT, LSAT, or MAT.

MPA Degree

Offered In (National Capital Region, Blacksburg, Richmond)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

All M.P.A. students must complete nine required 3-credit courses plus three elective courses of their choosing, for a total of 36 credit hours. The M.P.A. requires either 39 or 42 credit hours, depending upon whether students complete an internship or professional paper (39 credits for the M.P.A.) or thesis (42 credits for the M.P.A.). Entering MPA students must have taken at least one undergraduate course on the institutions of American government or have equivalent work experience or training. All students must also have taken an introductory statistics course or be taking one concurrently in order to enroll in PAPA 6514. To enroll in PAPA 6224, students must have completed statistics and PAPA 6514 or the equivalent. While we require PhD applicants to submit scores from one of the following graduate admissions tests: GRE, GMAT, LSAT, or MAT. Test scores for MPA applicants are optional.

GRADUATE COURSES (PAPA)

PAPA 5014:

Concepts and Approaches to Public Administration

Covers the origins and development of the administrative state. Surveys major theoretical approaches to public administration. Discusses the problem of values in administration, the political environment of bureaucracy, and questions of ethical behavior in administration.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5024 (UAP 5024):

Introduction To Public and Nonprofit Financial Management

Introduction to central concepts in financial management for public and nonprofit organizations. Accounting, financial statements and management reporting, auditing, internal control systems, accountability, and approaches to assessing the financial condition of public and nonprofit entities. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5034:

Democratic Governance in the Economy

An international and comparative examination of workplace and economic relations around the world, with special focus on efforts to build collaborative work processes that would extend the voice, ownership and control rights of workers. The interface between state institutions and economic organizations is also considered, especially insofar as government prescriptions and processes that may impede or extend democratic governance of the economy. Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5044:

Local Government and the Professional Manager

Covers the origin and development of the administrative state. Surveys major theoretical approaches to public administration. Discusses the problem of values in administration, the political environment of bureaucracy and questions of ethical behavior in administration. Particular attention given to the local government context and the local public manager's role. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5214 (SOC 5214):

Research Methods

Research methods in sociology including survey methods, qualitative methods, and experimental design. The link between social theory and social research. Measurement, validity, reliability, and the logic of data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5254:

HMLND SEC & TERRORIST THREAT

A multidisciplinary introduction to theory, strategy, decision making, and doctrine of Homeland Security as practiced in the U. S. Describes the threat, nature of current global conflicts in which the U. S. is engaged, America's foreign and domestic policy responses to 9/11, and strategic and operational homeland security functions. Pre-requisite: Graduate standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5315:

Government Administration

5315: The first of a sequence of two, provides theoretically grounded but practical knowledge on behavioral skills necessary for the public manager. These include the ability to lead, to supervise, to organize, and to communicate in public settings and in agencies serving the community and society. 5316: The second of a sequence of two, teaches the techniques and technology necessary to manage public organizations efficiently and effectively and to be held accountable for administrative actions and programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5316:

Government Administration

5315: The first of a sequence of two, provides theoretically grounded but practical knowledge on behavioral skills necessary for the public manager. These include the ability to lead, to supervise, to organize, and to communicate in public settings and in agencies serving the community and society. 5316: The second of a sequence of two, teaches the techniques and technology necessary to manage public organizations efficiently and effectively and to be held accountable for administrative actions and programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5354:

HMLND SEC & RESPONSE &RECOVERY

Multi-disciplinary policy course focused on emergency response and recovery following catastrophic manmade disasters in the U. S. Emphasis on strategic and operational decision making; response models and strategies; the preparations, response and recovery roles and responsibilities of federal, state and local jurisdictions; and federal policy alternatives to address the complex resource challenges of multi-jurisdictional response planning and operation execution. Pre-requisite: Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5464:

Qualitative Research Methods in Global Studies

Examines the philosophies and procedures guiding various qualitative methods used in the social science fields, such as global studies, planning and policy. Exploration of alternative understandings of normal science and consideration of the merits of adopting qualitative research approaches to disciplined analysis, including ethical issues in research. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5544:

Public and Non-profit Financial Management

Examines concepts central to effective financial management of public and non-profit organizations. Affords students an opportunity to further their understanding of the relationship between financial accounting and reporting systems and effective organization management. II

Credit Hour(s): 3

Lecture Hour(s): 3

463 Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): UAP 5514

Corequisite(s):

PAPA 5604:

Organizations in Society

Review of major theories and dimensions of modern organizations, especially technological and managerial arenas influenced by class and power. Labor processes internal to organizations and power networks among organizations. Includes cross-national comparisons.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5614:

Introduction to Science and Technology Policy

Strategies for science and technology policy; science education; scientific and technical information for societal uses; government and public policy; resource allocation; economy and global exchanges of science and technology; approaches to policy evaluation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5674:

Financial Health of Public and Nonprofit Organizations

Concepts and analytical capacities necessary to evaluate the overall level of financial health of governmental and nonprofit/nongovernmental organizations. Examines the tools and techniques necessary to assess the financial condition of the organizations and to determine if they have the capacity to carry out their purposes and address their debt obligations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5694 (UAP 5694):

Asset Management for Public and Nonprofit Organizations

Provides an understanding of asset management for governmental and nonprofit/nongovernmental entities. Focuses on the essentials of cash budgeting and cash management, investment of endowments and pension funds, and debt management and debt financing for governmental and nonprofit/nongovernmental organizations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5784:

Economic Devel Planning Topics

An introduction to local economic development programs. Covers intergovernmental relations, financing techniques, federal and local subsidies, advertising, marketing, public relations, labor market issues, tax considerations, fiscal impact analysis, and land use planning issues. May be repeated with different topics for a maximum of 9 credits.

Graduate standing required.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

PAPA 5954:

Internship in Public Administration/public Affairs

For students without substantial previous management or staff experience and for students changing positions or career. Supervised work and academic experience.

Credit Hour(s): 1 TO 15

Lecture Hour(s): 1 TO 15

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Corequisite(s):

PAPA 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

PAPA 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PAPA 6014:

Public Administration Theory

Examines the epistemological-ontological basis of public administration study; recent and current issues in the practice of public administration; and perspectives of the Center faculty concerning the direction of the field.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6024:

The Context of Public Administration

Examines the history of public administration as a field of study; the politico-economic context of public administration as an element of

governance; and international comparisons of public administrative behavior.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6114:

Complex Public Organizations

Examines the principal conceptual and theoretical bases for understanding the structure and environment of complex public organizations; also explores the problems bureaucracy poses for democratic theory and for vigorous economy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6124:

Behavior and Change in Public Organizations

Dynamics of behavior and change process in public sector organizations are examined for: (1) their implications for individuals, groups, and society; and (2) their impact upon organizational productivity and public policy. Critical dimensions of leadership as a sociopsychological process in management are emphasized with special reference to the public sector and public executives. The course also surveys the various types and strategies for planned change in public sector organizations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6154:

Advanced Topics in Public Organizations

Selected topics of theory, methodology, and design in current research literature on complex public organizations and large-scale bureaucratic systems. The political environment of such systems will be emphasized.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6194:

Capstone Seminar in Public Organizations

Advanced doctoral seminar involving original conceptualization and research into specific aspects of collective behavior, leadership, and change processes of complex, formal, public organizations. Foci for analysis include dynamics within, and linkages among small groups, organizations, and interorganizational networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6214:

Public Policy Processes and Analytical Approaches

Examines in a general way, the field of public analysis in and for government. Covers the traditions and assumptions of the field; notes and critiques the literature; examines relationships to other fields and topics of public administration; and discusses the processes of policy-making and techniques of analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6224:

Design, Implementation, and Evaluation of Public Policy and Programs

The general purpose of this course is to develop an understanding of the process by which policy is formulated, analyzed, implemented, and evaluated. The focus will be on such actions as undertaken by policy analysts in and out of government. The methodological issues and techniques used to accommodate the major social, economic, political, and behavioral aspects of policy analysis in an organizational context will be discussed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6254:

Advanced Topics in Public Policy

Selected topics in public policy analysis and program evaluation. Theoretical perspectives, methodological issues, and current research on selected policies and programs at international, national, or subnational levels, etc.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6264:

Advanced Topics in Policy Systems Management

Focus on critical integration of policy and management concerns in national strategy that represent a point of synthesis of external and internal policy arenas in such selected areas as: national and international security, politico-economic risk in overseas operations of U.S. institutions, crisis and emergency management, technoscience and resource systems, and information resource systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6294:

Capstone Seminar in Public Policy

Conceptualization and research into the processes of policy analysis and program evaluation in the public sector. Selected conceptual, methodological, organizational, and ethical problems associated with the analysis, implementation, and evaluation of public policies and programs.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6314:

Public Budgeting Processes and Their Policy Implications

Surveys the public budgeting processes of public organizations. The contrasting norms and behaviors of participants, their impacts on policy,

and their implications for democracy are examined. Processes studied include the work of budgeteers, decision making processes, control and financial accounting, and intergovernmental interaction.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6324:

Public Personnel Processes and Their Policy Implications

Surveys the key personnel processes of public organizations, the contrasting norms and behaviors of participants, their impacts on policy, and their implications for democracy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6344:

Ldrship & Mgt Process Pub Adm

Conceptual and theoretical bases for understanding leading and managing in the context of public organization processes and functions such as budgeting and financing human resource management, acquisitions, information technology, and planning. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6354:

Advanced Topics in Public Management

An examination at an advanced level of a selected managerial process in the public sector (civil and military), the norms and participant behavior associated with the process, its efficacy in planned change, and its overall impact on policy making and implications for democracy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6394:

Capstone Seminar in Public Management

Original conceptualization of and research into specific aspects of management processes in the public sector. Opportunities and problems in using management processes to institute planned change.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6414:

Normative Foundations of Public Administration

The course will examine the discretionary judgments of administrators as the central normative issue in the field of public administration and will look to constitutional principles for guidance in the responsible exercise of administrative discretion. Particular emphasis will be placed on selected court decisions to compare and contrast legal and moral reasoning.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6454:

Advanced Topics in Ethics and the Public Sector

This is an advanced course in the Center's curriculum area dealing with ethics and the normative theory of the state. It will examine the theoretical basis of ethical standards in the field of public administration. Special emphasis will be placed on the Ethics in Government Act of 1978 and the Code of Ethics of the American Society for Public Administration.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6494:

Capstone Seminar in Ethics and the Public Sector

467 Original research into specific aspects of professional ethics in the public

sector. Emphasis on particular problems for career personnel.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6514:

Public Administration and Policy Inquiry

Provides students with a general background in the design and execution of inquiry in public administration and policy. Includes examination of concepts, issues and problems of inquiry design, measurement, data collection, analysis, and the application of computers, and other information processing tools to support research and decisionmaking in public administration and policy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6524:

Advanced Quantitative Methods in Public Administration & Policy

Advanced quantitative methods for the public administration and policy, including logit and probit models, factor analysis, structural equation models, and social network analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PAPA 6514

Corequisite(s):

PAPA 6664 (STS 6664):

Advanced Topics in Science and Technology Policy

Variable topics in science and technology policy. Includes advanced study of science, technology, and economy; science, technology, and power; strategies for research and development policy --public and private sector; transfer of technology; technological forecasting; government regulation and responses; science policy assumptions and challenges, specialist knowledge and expertise; state and academic knowledge production; issues of race, class, gender, and national identity in policy work. May be repeated with a different topic for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 7954:

Internship in Public Administration/public Affairs

For students without substantial previous management or staff experience and for students changing positions or career. Supervised work and academic experience.

Credit Hour(s): 1 TO 15

Lecture Hour(s): 1 TO 15

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 7964:

Field Study

Applied research and/or evaluation study in cooperating government agency as part of a team of advanced graduate students and faculty.

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PAPA 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

TOEFL

Paper: (550.0)*Computer:* (213.0)*iBT:* (79.0)

GRE

URBAN AND REGIONAL PLANNING

Diane Zahm, Chair

Kris Wernstedt, Chair

Emeriti Faculty: James Bohland; John Randolph;**Professors:** John Browder; Sonia Hirt; Paul Knox; Charles Koebel; Thomas Sanchez;**Associate Professors:** Ralph Buehler; Max Stephenson; Kris Wernstedt; Diane Zahm;**Assistant Professors:** Margaret Cowell; Ralph Hall; Shalini Misra; Jocelyn Widmer; Yang Zhang;**Research Faculty:** Joseph Schilling;**Adjunct Professors:** Shelley Mastran; Minnis Ridenour;**Affiliated Faculty:** John Provo;**Professor of Practice:** Elizabeth Morton;**UAP Home:** <http://www.uap.vt.edu>**Graduate Site:** <http://www.uap.vt.edu/degrees/masters>

The Master of Urban and Regional Planning (MURP) program is a two-year (48 credit hour) interdisciplinary professional degree open to students from a wide variety of undergraduate fields. The program has a dual objective of training graduates for their first planning job, and more importantly instilling conceptual and critical thinking necessary for lifelong learning and career development. While the required core provides "generalist" planning theories and skills, one-half of the curriculum is in the student's area of specialization (including: economic and community development, environmental planning and policy, international development, physical development, public and nonprofit management, and social policy and planning) and provides substantive skills in a specific area of interest. Graduates are able to assume professional responsibilities in a wide variety of positions in public service or in the private sector. The program is accredited by the American Planning Association Planning Accreditation Board. The program's mission is to develop in students: An understanding of the economic, social, and environmental context of planning An understanding of the history and tradition of the planning profession An understanding of the use of basic planning theories, concepts, and skills Competence in an area of specialization Competence in quantitative and qualitative analysis Competence in the written and oral communication skills necessary to function as a planning professional The UAP graduate program is offered through two locations: the main campus in Blacksburg and in Old Town Alexandria (National Capital Region).

SPECIAL FACILITIES

Architecture Annex in Blacksburg and 1021 Prince Street, Alexandria VA, Northern Capitol Region

DEGREES OFFERED**MURPL Degree**

BA/MURP- Fourth-year architecture students may apply to the Graduate School for Combined Student Status provided they: 1. are within 24 semester hours of graduation; 2. have elected to pursue a Master Urban and Regional Planning degree combined with B.Arch studies; and 3. have a minimum 3.0 GPA for the last two years (60 credit hours) of undergraduate studies. The MURP degree will be awarded to students who earn a 3.0 or better GPA for courses applied to it from among the core (24-25 hours), specialization (minimum 12 hours including qualifying Architecture courses taken during the 5th year), and electives as needed to accumulate 48 hours. Students must also complete a capstone project. MURP Students must take 48 credit hours of work and complete a capstone project ---MIP Students must take 48 credit hours of work and complete a capstone project. MURP/MNR, MURP/MPA, MURP/MLA- Simultaneous degree students must be admitted to both programs following the admissions procedures in each. Students may apply for admission to both programs before enrolling in either, or they may apply after first being admitted to and enrolling in one. In the latter case, application to the second program should be made before half the coursework in the first has been completed. Following university guidelines, the capstone product required of each program will remain in effect. However, it is recognized that the capstone product for both may bridge the fields of each degree. Both degrees must be earned simultaneously although a student could opt out of one degree program to receive the other masters degree provided requirements of that degree are fulfilled. All grades earned in dual degree status are used for purposes of determining academic good standing, academic probation and graduate requirements. Students must be in good standing in both programs to continue in a simultaneous degree program. Students who are dismissed from either program are no longer considered to be in a dual degree program. These students may enroll in and use courses for credit toward the degree program in which they are in good standing only. Students may not take courses in the program from which they have been dismissed and may not use such courses for dual degree credit. The School of Public and International Affairs offers both a Master of Urban and Regional Planning and Public and International Affairs degree in conjunction with the Peace Corps through the Masters International Program (MIP). The MIP is designed to prepare students for their Peace Corps service as well as subsequent careers in international development, international nongovernmental organization management and leadership and planning. Electives and required core courses address such subjects as community and economic development, international development planning and policy, land use and environmental planning, public and non-profit organization governance and management, NGOs in international development. Students spend one year in graduate study and the next two years overseas as Peace Corps volunteers, integrating their experience and graduate studies. Students then return to VT for their final year to complete their chosen degree. Curriculum Students may apply to either the Master of Urban and Regional Planning (MURP) or Master of Public and International Affairs (MPIA) degree program. The Planning Accreditation Board of the American Planning Association accredits the MURP degree.

GRADUATE COURSES (UAP)

UAP 5004 (GIA 5004):

Power and Policy in the US

Social science theory and research on the distribution of power in the US, especially as it shapes important national policy outcomes. Institutional and class bases of power will be examined, including membership on corporate boards and in policy-shaping think tanks. Implications for democracy in society will be drawn. Graduate standing.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5024 (PAPA 5024):

Introduction to Public and Nonprofit Financial Management

Introduction to central concepts in financial management for public and nonprofit organizations. Accounting, financial statements and management reporting, auditing, internal control systems, accountability, and approaches to assessing the financial condition of public and nonprofit entities. Pre: Graduate standing.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5034 (GIA 5034):

Democratic Governance in the Economy

An international and comparative examination of workplace and economic relations around the world, with special focus on efforts to build collaborative work processes that would extend the voice, ownership and control rights of workers. The interface between state institutions and economic organizations is also considered, especially insofar as government prescriptions and processes that may impede or extend democratic governance of the economy. Graduate Standing.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5044:

Local Government and the Professional Manager

Covers the origin and development of the administrative state. Surveys major theoretical approaches to public administration. Discusses the problem of values in administration, the political environment of bureaucracy and questions of ethical behavior in administration. Particular attention given to the local government context and the local public manager's role. Graduate standing required.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):
Corequisite(s):

UAP 5064G:

Adv Pollution Cntrl Plan & Pol

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 and solid and hazardous wastes, toxic substances, and noise. Implementation of pollution control legislation, policies, and programs at federal, state and local levels.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5074G:

Adv Comm Renewable Energy Sys

Critical review of energy issues from local to international including economic, environmental, and social dimensions. Introduction to energy science, engineering, and economics. Application of energy and economic analysis to efficient and renewable energy systems in buildings, electricity, and transportation. Review and assessment of energy planning and policies for efficient and renewable energy at the local, state, and national levels. Pre-requisite: Graduate Standing required

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5084G:**Advanced Community Involvement**

Issues, concepts, and techniques of citizen participation in community development and planning. Theoretical foundation, institutional frameworks, and historical evolution of participatory democracy.

Exercises developing group communication skills, public meeting facilitation, and design of community involvement programs. Pre-

requisite: Graduate Standing Required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5104:**Urban and Regional Development Theory**

An examination and critique of theories relating to socio-economic development and change at three major scales (international, national/regional, and intra-urban) and of theories relating to the linkages between the dominant processes operating at these major scales.

Particular emphasis is given to the role of the state in urban and regional development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5114:**Computer Applications in Urban Planning and Management**

An examination of a wide range of computer-based techniques that are of value in analyzing urban and regional planning and management problems. Techniques include linear programming, goal programming; modeling of complex systems; and decision modeling. May be repeated with different content for a maximum of 12 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5224

Corequisite(s):

UAP 5124:**Urban and Regional Planning Studio**

Application of planning strategies to solve urban problems encountered

in professional practice. Includes methods and techniques for securing and analyzing relevant data; identifying goals and objectives; formulating proposals; formulating strategies to implement proposals; presentation of findings. May be repeated with a different studio application for a maximum of 6 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5134G:**Adv Land Use & Env: Plan & Pol**

Environmental factors involved in land use planning and development, including topography, soils, geologic hazards, flooding, and storm water management, ecological features and visual quality. Techniques for conducting environmental land inventories and land use suitability analyses. Policies and programs to protect environmental quality in land use planning. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5154:**Global Accountabilities**

Provides a comparative perspective on "accountability" among nonprofit and non-governmental organizations, private corporations, governmental organizations, and inter-governmental organizations. Theories and practices of accountability, reporting, monitoring, compliance and learning are considered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5164 (PSCI 5164) (GIA 5164):**Collaborative Governance and Civil Society**

Theoretical foundations of collaborative policy and governance approaches are examined. Strategies and methods for forming and sustaining collaborative coalitions are discussed. Case studies are used to illustrate the effectiveness of collaborative approaches in different

policy domains. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5174:

Theory and Practice of Urban and Regional Planning

Theoretical foundations of urban and regional planning. Methods and procedures employed in the professional practice of planning.

Examination of the interdependence of planning theory and planning practice.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5194:

Urban Growth Mgmt

Examines regulatory and financial techniques for controlling and guiding urban development. Evaluates their advantages and disadvantages with respect to development circumstances. Focus is primarily on the practice of local and state governments in the U.S. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): UAP 4754

Corequisite(s):

UAP 5214:

Topics in Natural Resources and Natural Hazards Planning

Concepts, theory, and practice of resilience-based, climate- change integrated natural resources management and hazards planning. Effects of land, water, soil, and ecosystem management on quality of life for present and future generations. Natural resources and natural hazards planning process and tools for local communities and policies at state and federal levels. May be repeated for a maximum of 9 credit hours.

Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5224:

Quantitative Techniques in Planning

A presentation of research techniques used in urban and regional planning with an emphasis on predictive techniques and the use of the computer.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

UAP 5234:

Urban Economy and Public Policy

This course applies principles of urban economics and microeconomics to the analysis of a range of urban problems, including: housing, employment, environmental quality, poverty, and the provision of urban services.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5244:

Multicultural

Examines the growing ethnic and demographic diversity of urban United States. Stresses theories and techniques that can be used to bring about more inclusive planning and public policies at all levels of government. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5254:

Global Conflicts

Examines theoretical issues in the study of global conflicts. Reviews theories of nationalism, states and territory as factors. Examines dynamics of contemporary conflicts from different regions of globe as case studies illustrating theoretical issues. Reviews role of leaders in

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5264:

Global Change and Local Impacts

All jurisdictions, national, regional, or local, function in an interconnected global market. Understanding the structure and interactions within that global market and the impacts therein is the focus of UAP 5264.

Thematic topics include a review of welfare state functions, privatization, decentralization, and nonprofit organizations and their relation to global market dynamics. Upon completion of the courses, students will have an understanding of how global forces influence local areas and how local leaders have developed strategies to cope with their position in an increasingly global market. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5264G:

Advanced Environmental Ethics and Policy

Issues in applied environmental ethics. Contributions of multi-cultural religious and spiritual traditions to contemporary perspectives on the human-nature relationship. Examination of selected issues in environmental ethics from utilitarian economic, deep ecology, and ecofeminist perspectives. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5274 (GIA 5274):

Comparative Social Movements

This course will investigate the forms of public protest that occur all over the world, with special attention to activism in poor nations and to the recent emergence of transnational movements. Also examines why and when governments repress social movements. Explores movements that are grounded in collective identities based in class, race/ethnicity, gender, religion, and culture. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5284:

Transnational Migration

Overview of the dynamics, policies, governance, and citizenship regimes associated with the phenomenon of transnational migration. The course will emphasize local, national, and supranational examples and comparisons to explore these themes. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5304:

Land Use Planning

Procedures for: (1) identifying the type, magnitude, and locational characteristics of urban land uses; (2) making projections of future land use; and (3) preparation of land use plans.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5314:

Social Analysis of Land Use Planning

Examines the underlying social and cultural values which shape U.S. land use and zoning policies. Analyzes zoning ordinances, historic preservation, environmental planning, housing, and urban design policies for their explicit and cultural meanings. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 4754

Corequisite(s):

UAP 5324:

Introduction to infrastructure planning and development practices in developing countries. Study of practices to address the complex challenges facing many developing regions. The current state of practice for the provision of infrastructure services. Role of public/private local, regional, and national planning/development agencies and international organizations and groups. May be repeated with different topics for a maximum of 9 credits.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5344G:

Adv Law Critical Envir Areas

Examines the legal principles and policy debates involved in the regulation and protection of critical environmental resources. Variable topics including wetlands law and policy, endangered species habitat, open space, forestland and farmland protection, coastal zone management, and floodplain regulation and policy. Pre-requisite:

Graduate Standing Required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5354:

Charity, Philanthropy and Civil Society

This course treats the evolution of philanthropy and charity in the United States and abroad and introduces major issues and continuing concerns linked to the institutions engaged in these activities while exploring their ties to civil society. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5364:

Non-Governmental Organizations in International Development

Explores theory and cases of non-governmental organizations in international development. Analyzes various roles of NGOs, and their interactions with local communities, government agencies, international

organizations, and private businesses. Examines tensions and collaborations between NGOs and other development actors, drawing from cases in environmental, health, and educational policy domains. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5384:

Housing and Infrastructure Planning in the Third World

An introduction to housing problems in developing countries and alternative policy approaches to them. The course examines the formal and informal housing sectors and asks why the housing sector is important for both national governments and international organizations. It traces changes in the way housing problems have been identified and in the solutions proposed to them. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 4764

Corequisite(s):

UAP 5414:

Natural Resources Planning Topics

The natural resource planning process as implemented by federal public lands and water resources agencies in the U.S. Public participation, environmental impact assessment, and resource evaluation methods used in planning and decision-making. Applications to resources planning in developing countries. May be repeated with different topics for a maximum of 9 credits. Graduate standing required.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5424:

Metropolitan Planning Topics

A topics course focusing on the methods and techniques of evaluating physical development needs of metropolitan areas their sub-areas. Emphasis on elements of land use, physical development needs, representation, and the role of comprehensive plans and implementing regulatory ordinances (zoning, land subdivision regulations, building

codes, environmental regulations). May be repeated with a different topic for a maximum of 12 credits.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5434:

Urban Development Project Review Studio

A studio focusing on the theory, methods, and techniques of evaluating physical development projects. Emphasis on evaluation criteria implied in public policy, as expressed in comprehensive plans and implementing regulatory ordinances (zoning, land subdivision regulations, building codes, environmental regulations).

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5454:

Nonprofit Organization & Management

Examines the nonprofit sector in American society and compares those roles with the roles the sector plays in other advanced democracies as well as in developing countries. Also analyzes the role of important sub sectors within the nation's third sector and explores key management challenges confronting non-profit organization leaders with them.

Compares those challenges to those found in nongovernmental organizations in developing nations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5464 (GIA 5464):

Qualitative Research Methods in Global Studies

Examines the philosophies and procedures guiding various qualitative methods used in the social science fields, such as global studies, planning and policy. Exploration of alternative understandings of normal science and consideration of the merits of adopting qualitative research approaches to disciplined analysis, including ethical issues in research. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5484:

Advanced Urban Research Methodology

The various methodological approaches used in the fields of urban planning and in public policy to analyze causes of problems and thus suggest policy recommendations. Emphasis is on defining the research problem, developing an appropriate research design, data collection, and fundamental techniques of data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5494:

Advanced Quantitative Techniques for Urban Research

Advanced quantitative techniques used in urban analysis. Application of the methods to situations encountered in urban planning, urban policy analysis, and urban management are stressed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5484

Corequisite(s):

UAP 5504 (GIA 5504) (PSCI 5504):

Discourse Analysis

Examines the key theoretical sources and major practical applications of discourse analysis as a contemporary social science methodology.

Origins, major variants, and critical uses of discourse analysis in cultural studies, semiotic methods, policy analysis, and organizational communication techniques also are considered. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5524 (GIA 5524):**Internat Development**

Social and cultural factors in the development of societies, including the role of women in development. Contemporary developing countries, and historical material from developed countries; policy issues facing governments of developing countries and those interested in assisting their development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5534:**Nonprofit Organization Leadership and Governance**

Major conceptual issues related to developing an understanding of the foundations and roles of leadership and governance of third sector and nongovernmental organizations. Comparison of nongovernmental organizations in the U.S. and around the world. The course is designed to equip students with the capacities to assess and improve organizational governance effectiveness as well as to devise and implement leadership strategies in the complex structural, social and political contexts in which these organizations are typically enmeshed in the United States as well as in other industrialized democracies and in developing nations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5544:**Public and Non-profit Financial Management**

Examines concepts central to effective financial management of public and non-profit organizations. Affords students an opportunity to further their understanding of the relationship between financial accounting and reporting systems and effective organization management. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5514

Corequisite(s):

UAP 5554:**Land Use Law**

State enabling legislation; police power of the state; nuisance; land use regulation; subdivision regulation; exclusionary zoning; growth management; environmental controls.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 4754

Corequisite(s):

UAP 5564:**Information Technology, Society, and Public Policy**

Social impacts of new and emerging information technologies from a public policy perspective. Technical nature of IT and influences of IT on four core dimensions of society: political, economic, cultural, and spatial. Course integrates theoretical and philosophical literature on IT with applied policy and planning issues.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5574:**Arts, Culture and Society**

Considers the role of the arts in society, including architecture, music companies, or theater productions to heritage sites, science museums, and art galleries. Effective arts policy in revitalizing urban economies also examined. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5584 (GIA 5584) (PSCI 5584):**Environmental Politics and Policy**

Course provides a broad introduction to the key ideas, actors and institutions related to environmental politics and policy in the United States, with some coverage of global issues. It is intended to provide students with basic interdisciplinary knowledge and an intellectual framework for understanding and thinking critically about environmental politics and policy.

476 Credit Hour(s): 3

Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5594:

Nonprofit Law and Ethics

Explores the legal, ethical and normative systems affecting nonprofit and nongovernmental organizations, both domestically and internationally.

Examines the historical foundations of legal regulation and professional ethics within the sector and how these systems contribute to the administration and governance of nonprofit and nongovernmental organizations. Also surveys current theories of nonprofit/nongovernmental organization regulation as well as major legal and ethical issues confronting the sector. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5604:

Housing Planning and Policy Topics

An examination of national and local housing markets with emphasis on the impact of various public housing policies on the demand for and supply of housing within these markets. The relationships between public and private delivery systems. May be repeated with different topics for a maximum of 9 credit hours. Graduate standing required.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5234

Corequisite(s):

UAP 5624:

Urban Design Seminar

Current topics in urban design. Topics may include: theoretical, conceptual and practical concerns in the generation of urban spatial form; the roles of public and private interests in shaping urban form; the effects of urban intensification on the quality of public spaces; environmental issues in urban design; the role of public policy and regulatory mechanisms; the genesis and development of urban typologies. Each seminar will address one of these or related subject areas. Course may be repeated with a different subject for a maximum

of 12 credits. I,II.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5634:

Urban Design Studio

Urban design studio projects involving the translation of design and planning theory and methodology to actual form-giving proposals for the urban context. Emphasis will be on the development of urban tectonic form in response to functional and behavioral planning, symbolic and aesthetic factors. May be repeated for a maximum of 12 credit hours.

Credit Hour(s): 0 TO 12

Lecture Hour(s): 0 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ARCH 4715

Corequisite(s):

UAP 5644:

Transportation Systems Planning

Advanced consideration of problems dealing with transportation systems as they affect the socio-economic development of cities, regions, and nations; the travel behavior of a populace; the location of economic activity; the use of land; and the allocation of resources. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CEE 3604

Corequisite(s):

UAP 5654:

Environmental Risk Analysis

This course will provide an overview of risk analysis as it pertains to environmental policy, including distinguishing among various concepts of risk, methods employed in risk analysis, public policies regarding risk analysis, the challenges of risk communication, proposed alternative approaches to risk assessment, and the political controversies surrounding risk analysis in the broad field of environmental regulation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): PSCI 5115, PSCI 5116 OR UAP 5144, STAT 5665

Corequisite(s):

UAP 5694 (PAPA 5694):

Asset Management for Public and Nonprofit Organizations

Provides an understanding of asset management for governmental and nonprofit/nongovernmental entities. Focuses on the essentials of cash budgeting and cash management, investment of endowments and pension funds, and debt management and debt financing for governmental and nonprofit/nongovernmental organizations. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5704:

Electronic Governance

Examines applications of information technology in government from the point of view of governments and citizens. Survey of the relationship between e-government and e-democracy and of government management techniques. Explores problematic issues related to e-government, such as privacy, the digital divide, and information security.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5214, PSCI 5554 OR UAP 5564

Corequisite(s):

UAP 5714:

Community Building Seminar

A comprehensive examination of community development theories and methods. Emphasizes community contexts across the scales of family, association, neighborhood, city, region, and nation. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5724G:

Adv Cap Budg & Strat Fac Plan

Examines the principles and practice of capital budgeting as a primary instrument for the effecting of long-range policy objectives. Pre-requisite:

Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5744:

Planning Internship

Student placement in an organization engaged in planning or related work with the guidance of a faculty member. Variable credit course.

Maximum of three credit hours per semester, but may be repeated for a total of six credit hours.

Credit Hour(s): 1 OR 3

Lecture Hour(s): 1 OR 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5174

Corequisite(s):

UAP 5754:

Metropolitan Planning Seminar

Issues, concepts, and debates surrounding contemporary metropolitan planning and development policy through discussions, special lectures by faculty, and/or guest lectures by experts prominent in their field. May be repeated for a maximum of four credits.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5764:

International Development Studio

International development project initiation and institutional framework; project design processes, criteria, and methods; implementation and evaluation design processes, criteria, and methods. Examination of case projects by public and private donor agencies as a basis for project design. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 4764

Corequisite(s):

UAP 5764G:

Advanced International Development Planning and Policy

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.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5774:

Econ Develop Studio

Principles, concepts, and techniques related to economic development at either the local and regional scale are brought to bear in solving a development problem. Emphasis is on problems which are encountered in planning or implementing economic development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5234 OR UAP 5104

Corequisite(s):

UAP 5784:

Economic Development Planning Topics

An introduction to local economic development programs. Covers intergovernmental relations, financing techniques, federal and local subsidies, advertising, marketing, public relations, labor market issues, tax considerations, fiscal impact analysis, and land use planning issues. May be repeated with different topics for a maximum of 9 credits.

Graduate standing required.

Credit Hour(s): 1 TO 3

Lecture Hour(s): 1 TO 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5794:

Environ Plan Studio

Application of environmental planning techniques involving either land use or residuals management in a specific project.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5804:

Practicum Problem

The practicum is one option (together with the major paper and thesis) which MUA and MURP Degree candidates may elect to complete their degree requirements. It is intended to provide the candidate with an opportunity to demonstrate: (1) a required degree of comprehension of the concepts, principles and techniques relevant to these fields, and (2) the ability to apply this understanding in a professional manner in a situation which simulates professional practice.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5124 OR UAP 5144

Corequisite(s):

UAP 5844:

Topics in Planning History

A topics course on the history of planning. Emphasis on social, cultural, economic, legal and political influences shaping planning and planning movements from historical perspectives. May be repeated with a different topic for a maximum of 9 credits. Graduate standing required.

Credit Hour(s): 1 TO 9

Lecture Hour(s): 1 TO 9

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 5854G:

Adv Plan Urban Infrastructure

Elements of the built environment and the policy/planning structure of the city. 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-requisite: Graduate Standing required

Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5864:

Topics in Transportation Policy and Planning

Overview of major policy and planning issues in transportation; interdependence of transportation with land-use patterns. Analysis of problems of transportation systems, and alternative solutions examined in the context of the changing political/institutional environment. May be repeated with a different topic for a maximum of 9 credits. Pre-requisite: Graduate Standing required.
Credit Hour(s): 1 TO 3
Lecture Hour(s): 1 TO 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5894:

Final Examination

I
Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5904:

Project and Report

I
Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

UAP 5914:

Peace Corps Service

Critical evaluation and field-based study of selected complex issues related to society in international context; study of cultural and language diversity; approaches to ethnoinclusiveness in urban and suburban environments; focus on practical local and regional planning for the

benefit of local communities in consort with non-profit organizations, governments and global networks. Pre-requisite: Graduate Standing and enrollment in the Masters International Program and Peace Corps.

Credit Hour(s): 6
Lecture Hour(s): 6
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5924:

Peace Corp Enrollment

Credit Hour(s): 0
Lecture Hour(s): 0
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5954:

Study Abroad

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5964:

Field Study

I
Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

UAP 5974:

Independent Study

I
Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Independent Study
Instruction Type(s): Independent Study
Prerequisite(s):
Corequisite(s):

Associate Professors: Jason Grant; Gordon Groover; Wen You;

Assistant Professors: Sarah Asebedo; Kimberly Morgan;

General Contact: jolewis@vt.edu

Student Handbook: <http://www.aaec.vt.edu/graduate/files/Student-Planning-Guide.pdf>

The Department of Agricultural and Applied Economics (AAEC) offers a very strong and growing graduate program. The program provides exciting study and research opportunities for students and has an outstanding record of graduate student placement. AAEC offers a M.S. in Agricultural Economics, with either an applied economics or agribusiness management and marketing focus, and a Ph.D. in Economics jointly with the Department of Economics. For the M.S. with applied economics focus, a student may select courses from a broad-based economics curriculum or may specialize in a specific field of interest. Students may develop specialties in diverse areas including, but not limited to, Econometrics and Quantitative Methods, Natural Resource and Environmental Economics, Management and Finance, Marketing and Price Analysis, International Development and Trade, and Rural and Regional Development. For the M.S. with agribusiness focus, students pursue specializations in management science, management, finance, or marketing. The M.S. with applied economics focus offers both thesis and non-thesis options. The M.S. with agribusiness focus is a non-thesis degree. Students enrolled in the Ph.D. program may use their Ph.D. coursework to simultaneously earn a master's degree. In the joint Ph.D. program with the Department of Economics, Ph.D. students take a common set of core courses in the first three semesters of the program and a common written qualifying examination. AAEC Ph.D. students then complete field courses in each of their two major fields, and elective courses that support their areas of research specialization. AAEC offers fields in: - applied econometrics, - environmental and resource economics, - food and health economics, - international development and trade, and - rural and regional development. Graduate students pursuing M.S. and Ph.D. degrees are eligible for graduate teaching assistantships and graduate research assistantships.

SPECIAL FACILITIES

Students on assistantship are allocated office space in the department and offices are made available to those students not on assistantship as space allows. All students have access to a well-equipped graduate computer laboratory with microcomputers, laser printers, and scanners. Many graduate students are allocated personal computers in their office facilities. Computers are networked to servers, which provide a wide variety of word processing, statistical, spreadsheet, mathematical programming, and other software.

DEGREES OFFERED

MS Degree

TOEFL

Paper: (620.0)

Computer: (260.0)

iBT: (105.0)

GRE

UAP 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lab, Lecture, Online Lecture

Instruction Type(s): Lab, Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

UAP 5994:

Research and Thesis

I

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

UAP 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

UAP 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

AGRICULTURAL AND APPLIED ECONOMICS

Steven Blank, Head

Professors: Jeffrey Alwang; Steven Blank; Darrell Bosch; Kevin Boyle; Richard Crowder; George Davis; Michael Ellerbrock; Leighton Geyer; Ruth Lytton; Achla Marathe; Mary Marchant; Bradford Mills; George Norton; James Pease; Everett Peterson; Stephen Stephenson; Daniel Taylor;

Offered In (Blacksburg)

General Test: Verbal (500.0), Quantitative (500.0)

M.S. degree: The general requirements for the master's degree thesis option are: (1) a minimum of 30 semester hours, including 24 hours of coursework and 6 hours of research and thesis (AAEC/ECON 5994), (2) completion of a thesis acceptable to the student's advisory committee, and (3) satisfactory performance on a final oral examination. The general requirement for a M.S. degree with applied economics focus non-thesis option is a minimum of 30 semester hours of coursework of which at least 24 hours must be at the 5000-level or above. For the M.S. degree, a student must also pass a final oral or written examination. The general requirements for the M.S. with agribusiness focus are (1) a minimum of 36 semester hours, including 30 hours of coursework and 6 hours associated with developing and conducting a case study (AAEC/ECON 5904), and (2) satisfactory performance on a final oral examination.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (620.0)

Computer: (260.0)

iBT: (105.0)

GRE

General Test: Verbal (500.0), Quantitative (500.0)

Ph.D. degree: The Graduate School requirements for a Ph.D. degree include a minimum of 90 semester hours of graduate credit beyond the baccalaureate, with at least 27 hours of coursework and 30 hours of Research and Dissertation (AAEC/ECON 7994). For the Ph.D. degree in Economics, there are additional core coursework requirements. In the first year of the program, the core requirements include one semester each of mathematical economics and macroeconomic theory, and two semesters of microeconomic theory and econometric theory. In the second year of the program, the core requirements include one semester of applied microeconomic theory, one semester of microeconometrics, and one semester of macroeconomic theory. Beginning in the second year of the program, Ph.D. students are required to complete two field courses in each of their two fields, and at least one elective course that supports their fields and areas of research specialization. Beyond the core coursework requirements, individual programs of study are determined jointly by the student and his/her advisory committee chair. Students who are admitted to the Ph.D. program without having completed a master's degree at another institution often earn an M.S. at Virginia Tech as part of their Ph.D. program. The credit hours applied to the master's degree can also be counted toward the Ph.D. coursework requirements. A similar rule applies for students who are initially in a master's degree program and are subsequently admitted to the Ph.D. program. In addition to coursework, Ph.D. students are required to pass three examinations: (1) a written qualifying examination, (2) a written and oral preliminary examination, and (3) a final oral dissertation defense. More information on these requirements is available at the Department's Graduate Program website.

GRADUATE COURSES (AAEC)

AAEC 5004:

Seminar

Formal presentation and discussion of current problems, programs, and research studies in agricultural economics. Presentations and discussions. Repeatable for credit. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5024:

Mathematical Programming for Economist

Employing economic principles to optimally achieve the goals of firms as a "whole." Linear, non-linear, and integer programming are employed to model firm decision making. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AAEC 3004 (UG) OR AAEC 3004 OR ECON 3104 (UG) OR ECON 3104

Corequisite(s):

AAEC 5025:

Applied Microeconomic

Basic economic theory of food and fiber production, food and fiber consumption, agricultural markets, and social welfare as influenced by the agricultural sector. Major emphasis placed on application of theory to current agricultural and resource problems. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (MATH 1526 (UG) OR MATH 1526, ECON 3004 (UG) OR ECON 3004) OR (ECON 3104 (UG) OR ECON 3104)

Corequisite(s):

AAEC 5026:

Applied Microeconomics

Basic economic theory of food and fiber production, food and fiber consumption, agricultural markets, and social welfare as influenced by the agricultural sector. Major emphasis placed on application of theory to current agricultural and resource problems. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (MATH 1526 (UG) OR MATH 1526, ECON 3004 (UG) OR ECON 3004, ECON 3104 (UG) OR ECON 3104)

Corequisite(s):

AAEC 5034:

Agribusiness Marketing

Marketing tools needed to identify and solve the complexity of marketing food and agribusiness products. Contemporary trends, marketing strategies, and problems in the food and agribusiness sector. Pre: Understanding of introductory microeconomic theory. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5104:

Research Project Plan

Planning and executing a research project with emphasis on problem identification, formulation of hypothesis, choice of appropriate empirical technique and data sources. II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5114:

Applied Microeconomic Theory

Theoretical and empirical issues in developing and implementing microeconomic models. Topics include duality, risk, household production, selecting functional forms, aggregation, and numerical partial and general equilibrium models.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5006, (AAEC 5126 OR ECON 5126)

Corequisite(s):

AAEC 5125 (ECON 5125):

Empirical Research Methods in Economics

Extensive treatment of new techniques for economic modeling. 5125:

Probability and statistical inference, linear regression and related dynamic models, specification, estimation, misspecification, respecification, identification. 5126: Simultaneous equations, dynamic systems, time series, limited dependent variable models. Permission of the Director of the Graduate Studies required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5126 (ECON 5126):

Empirical Research Methods in Economics

Extensive treatment of new techniques for economic modeling. 5125: Probability and statistical inference, linear regression and related dynamic models, specification, estimation, misspecification, respecification, identification. 5126: Simultaneous equations, dynamic systems, time series, limited dependent variable models. Permission of the Director of Graduate Studies required. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AAEC 5125 (UG) OR AAEC 5125

Corequisite(s):

AAEC 5134:

Agricultural Marketing

Concepts of technical and economic efficiency as they are related to the flow of agricultural products from farm to consumer. Major topics include: market equilibrium over time, space and form; price discovery under different market structures, and price risk management with futures and options. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 3104 (UG) OR ECON 3104

Corequisite(s):

AAEC 5144:

Resource and Environmental Economics

Economic theory and methods are applied to analysis of the uses of natural resources, environmental problems and public investment

formulation is stressed. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 3104 (UG) OR ECON 3104 OR AAEC 3004 (UG) OR AAEC 3004

Corequisite(s):

AAEC 5154:

International Agricultural Development and Trade

This course focuses on the role of agriculture in economic development and the effects of alternative trade policies and practices in less developed nations. Topics include agriculture in theories of development, population growth, migration, the economic organization of the peasant-household firm, technological change, institutional change, effects of trade restrictions, exchange rates, trade preferences, regional economic groupings, food aid, trade negotiations, agricultural sector marketing, and project analysis. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ECON 3104 (UG) OR ECON 3104

Corequisite(s):

AAEC 5174:

International Agricultural Development and Trade

Agriculture in world economic development, agricultural modernization strategies, and the effects of trade policies and agreements on agriculture. Dimensions of world food, population, income, and natural resource issues; technological and institutional change; trade, capital flows, and foreign aid. Pre. Understanding of introductory microeconomic and macroeconomic theory. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5244:

Rural Development

Theory and methods related to economic development of rural America. Considers the roles of agriculture, resources, human capital, and federal, state and local governments in development processes. Outlines the constraints created by resource scarcity, location and government policy.

Quantitative methods in resource development, regional development and impact analysis are introduced. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5804G:

Fundamentals of Econometrics

Introduction to economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations, instrumental variables, panel data methods. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

AAEC 5945:

Econometric Theory and Practice

An intensive coverage of the most important techniques of econometric estimation and hypothesis testing, addressing the use of both cross-section and time series data. A core sequence in the MA program in both locations. Prerequisite to the research-thesis seminar in Northern

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 2115 (UG) OR ECON 2115 OR ECON 2116 (UG) OR ECON 2116 OR ECON 2005 (UG) OR ECON 2005 OR ECON 2006 (UG) OR ECON 2006 OR ECON 2125 (UG) OR ECON 2125 OR ECON 2126 (UG) OR ECON 2126 OR ECON 2025 (UG) OR ECON 2025 OR ECON 2026 (UG) OR ECON 2026

Corequisite(s):

AAEC 5946 (ECON 5946):

Econometric Theory and Practice

An intensive coverage of the most important techniques of econometric estimation and hypothesis testing, addressing the use of both cross-section and time series data, A core sequence in the MA program in both locations. Prerequisite to the research-thesis seminar in Northern Virginia. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 2115 (UG) OR ECON 2115 OR ECON 2116 (UG) OR ECON 2116 OR ECON 2005 (UG) OR ECON 2005 OR ECON 2006 (UG) OR ECON 2006 OR ECON 2125 (UG) OR ECON 2125 OR ECON 2126 (UG) OR ECON 2126 OR ECON 2025H (UG) OR ECON 2025H OR ECON 2026H (UG) OR ECON 2026H

Corequisite(s):

AAEC 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

AAEC 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

AAEC 6004:

Seminar

Formal presentation and discussion of current problems, programs, and research studies in agricultural economics including projects employing advanced theoretical and quantitative techniques. Presentations and discussions. Repeatable for credit, up to 3 (M.S.) or 4 (Ph.D.) times. I,II,III,IV

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 6214:

Food and Health Microeconomics

Microeconomics of food and health. Overview of nutrition recommendations and implications for economic decisions. Individual and household food consumption and health production models. Farm to consumer market linkage models with nutrition and health implications.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AAEC 5126, ECON 5006, ECON 5016, ECON 5124

Corequisite(s):

AAEC 6224:

Introduction to policy and intervention design and evaluation, including review of basic nutrition, contract theory and applications, intervention outcome metrics, nonmarket evaluation, empirical cost effectiveness analysis and treatment effect estimations.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5006, (ECON 5126 OR AAEC 5126)

Corequisite(s):

AAEC 6304:

International Trade and Finance

Core models in international trade and finance; current topics in international economics. Ricardian, Hecksher-Ohlin-Samuelson, Dynamic imperfect competition trade theories; Political economy of trade; Trade policy, Factor mobility, Uncertainty, and Intra-industry trade. Mundell-Fleming, Monetary, Real- and Imperfect competition- Micro-foundations theories of international macroeconomics; exchange rate determination; and capital markets. Extensions to monetary and fiscal policy, economic growth, and external debt analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5005, ECON 5015

Corequisite(s):

AAEC 6314:

Topics Applied Dev Econ

Economic theories and empirical methods for measuring poverty, inequality, and vulnerability, and for targeting social programs. Topics include theory of the farm household and empirical methods to measure effects of public policies, interactions between the environment and development policy, methods for measuring technical change and its impacts, effect of social networks on technology adoption, and the role of microfinance in economic development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5006, ECON 5126

Corequisite(s):

AAEC 6444:

Regional and Urban Economics

An advanced study of the theory and application of regional and urban

economics, with particular focus on the spatial aspects of economic activity. Topics include: nature of regional and urban areas, models of regional economies, location choice of firms and consumers, local public finance, housing, transportation, and labor markets. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5005 (UG) OR ECON 5005, (ECON 5126 (UG) OR ECON 5126 OR AAEC 5126 (UG) OR AAEC 5126)

Corequisite(s):

AAEC 6454:

Dynamic Analysis

Advanced treatment of the analysis and optimization of dynamic economic systems using mathematical tools and analytic concepts. Topics include: optimal control theory; dynamic programming; economics of resource allocation over time; and stochastic optimization models. Permission of course instructor required. Alternate years. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AAEC 5025 (UG) OR AAEC 5025, AAEC 5124 (UG) OR AAEC 5124

Corequisite(s):

AAEC 6524:

Env Theory & Policy Analysis

Advanced coverage of the theory of environmental economics and policy. Topics covered in the course include: theory of externalities and public goods, theory behind policy instruments, issues with non-point source and transboundary pollution, and the role of the political economy for environmental problems.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ECON 5006

Corequisite(s):

AAEC 6554:

Panel Data Econometrics

Introduction to major panel data techniques and modeling ideas currently employed (e.g., dynamic panel, panel for discrete choice model, treatment effect and program evaluations etc.), including both statistical theory derivations and practical applications

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (AAEC 5124 OR ECON 5124), AAEC 5126

Corequisite(s):

AAEC 6564:

Robust Econometric Methods

Discussion and application of various methods to estimate economic models that are robust to a variety of common shortcomings inherent in classical models. Includes the use of quantile and median estimation, outlier detection, kernel smoothing, consistent model specification testing, nonparametric system and moment estimation, and bootstrap methods. Asymptotic theory necessary to understand the relative performance of estimators and tests will be thoroughly covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): AAEC 5126

Corequisite(s):

AAEC 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AAEC 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

AGRICULTURAL AND EXTENSION EDUCATION

Rickie Rudd, Head

Professors: Rickie Rudd;

Associate Professors: Eric Kaufman; Donna Westfall-Rudd;

Assistant Professors: James Anderson; Thomas Archibald; Curtis Friedel;

Kimberly Niewolny; Hannah Scherer; Matthew Spindler;

Community Viability Chair of Excellence: Rickie Rudd;

Graduate Contact: jcanders@vt.edu

Graduate Site: <http://www.alce.vt.edu/student-info/graduate/index.html>

The Department of Agricultural and Extension Education is nationally recognized as a comprehensive program encompassing teaching and learning, extension, and leadership in agriculture. We are social scientists practicing in the context of agriculture and life science. Our research, teaching, and extension programs enhance and strengthen the people engaged in agriculture life sciences. Graduate studies in AEE are grounded in our programmatic research in problem solving, leadership development, critical thinking, program development and evaluation, secondary education, non-formal education, and professional development. These research areas form our concentration areas of teaching and learning, community viability, and leadership & social change.

SPECIAL FACILITIES

Virginia Tech's Department of Agricultural and Extension Education is located in Litton Reaves Hall. In addition, we work with county extension offices and secondary schools across the state.

Litton Reaves Hall

The main office for AEE is located in 2270 Litton Reaves. Many faculty offices and the offices for the Virginia FFA Association and the Virginia Agricultural Education Curriculum Specialists are also located in Litton Reaves. Our Teaching and Learning Laboratory is located in room 244. This state of the art laboratory is utilized in conducting research in a classroom setting to test teaching and learning theory and study other phenomena where people are faced with stimuli in a social science setting.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

The department offers a M.S degree and partners in two other M.S. degree programs. The department offers a M.S. in Life Sciences with an emphasis in Agricultural and Extension Education (MSLFS). We are a partner in the College of Agriculture and Life Sciences for the MALS (Master of Agriculture and Life Science) degree. In addition, we are a partner with the Virginia Tech School of Education in offering an M.S.

degree for agriculture teacher certification MSSED/EDCT. MSLS/AEE The Master of Science requires students to complete a thesis and final examination. A considerable amount of time is spent conducting research and writing. This degree is intended for students who plan to pursue a Ph. D. in teaching and learning, community viability, or leadership & social change. MALS (Education Concentration) The Master of Agriculture and Life Science is a non-thesis degree intended for practicing professionals in education and extension. This degree is delivered by distance to students who are place-bound. Although this degree is intended for students who do not wish to pursue a doctoral degree, it does not eliminate students from that academic option if chosen in the future. Each student will complete a final project that adds to the knowledge base of best practices in our profession. The project defense (final examination) will be held at the end of a student's program. MSSED/EDCT The Master of Science in Career and Technical Education is offered on the Virginia Tech campus for students seeking certification in teaching secondary agricultural education. This program is housed in the School of Education and delivered in partnership with AEE. Students who complete the program receive a degree from the School of Education. This is a non-thesis degree. Students are required to pass a comprehensive examination to complete the program.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Ph. D. in Life Sciences with an emphasis in Agricultural and Extension Education (LSAE) is intended for students who desire to be faculty in universities delivering comprehensive programs in agricultural and extension education. Our program focus allows us to deliver a customized program for students preparing for the Professoriate. Courses, experiences, and research are all focused on providing a solid foundation for future faculty who will be initially competitive and highly productive throughout their career. Our Ph. D. program provided a solid background in research and students are expected to produce unique discoveries in teaching and learning, community viability, and leadership & social change. Students are expected to publish and present in the program as well as assist in securing funded projects. Faculty members work with students to meet individual educational goals. Our faculty are known for strong advisement and personal attention for each student. Students are provided with opportunities to teach in formal classrooms and non-formal settings, conduct meaningful research, and deliver outreach program. The degree requires a comprehensive examination to enter Ph. D. candidacy. The comprehensive exam and oral defense is an opportunity for a student to showcase their abilities in the areas of integrating and synthesizing information relevant to their program. Advisor and committee member roles at this stage include 1) providing support and encouragement, 2) providing collegial and constructive dialogue, 3) creating an environment where ideas are shared in a professional environment free of condescension, derision and hostility, 4) providing feedback in a timely manner and 5) completing their tasks with all relevant signatures or other paperwork. Each student will complete a dissertation that adds to the knowledge base of our profession. The dissertation defense (final examination) will be held at the end of a student's program.

GRADUATE COURSES (AEE)

AEE 5004:

Teaching Practice Ag Life Sci

Preparation of critically reflective and skillful college teachers in agriculture and life sciences. Theories, principles and practices associated with effective teaching in higher education. Understanding and development of skills and abilities related to teaching and learning.

Pre: Graduate standing.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5014:

Non-Formal Teaching & Learning: Principles & Methods

Principles and methods associated with non-formal teaching and learning for community and extension education as well as secondary educational settings such as agricultural education. Concepts and practical knowledge for designing, integrating, and justifying non-formal educational experiences for learners. Learning frameworks and approaches that emphasize the role of participation, facilitation, and other student-centered teaching and learning approaches in agriculture and life science professions. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5034:

Teaching Agricultural Mechanics

The coordination of essential elements required for an effective agricultural mechanics program. Special emphasis placed upon integrating agricultural mechanics instruction into a local agricultural education program, liability, curriculum content selection, special teaching methodologies and student assessment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5044:**Program and Curriculum Design in Agricultural and Extension Education**

Methods involved in the organization, management, and evaluation of programs and curricula for agricultural education and cooperative extension.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5054:**STEM Integration in Agricultural Education**

Contemporary methods, strategies, and justification for incorporation of science, technology, engineering and mathematics (STEM) concepts and practices into secondary agricultural education programs. Use of best practices for STEM teaching and learning and enhancement of STEM content in existing agriculture courses. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5074:**Foundations of Agricultural and Extension Education**

The history and philosophy of agricultural education and the cooperative extension service along with the inter-relationship of the two, including a common heritage. Leaders of both agencies, along with their philosophies, are discussed.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5104:**Research Applications in Agricultural and Extension Education**

Professional applications of research from the perspective of the research consumer rather than the researcher. Locating, accessing, interpreting, evaluating, applying, and communicating the results of research to the lay public in agricultural and extension education

settings. Emphasis on professional and scientific research published in agricultural, applied life sciences, agricultural education, and cooperative extension outlets.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5114:**Serving International Agriculture & Education**

International agricultural and outreach education in both developed and developing countries. Skills formal and non-formal educators need in an international setting. Especially for educators and leaders in agriculture and Cooperative Extension. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5154:**Partnerships and Volunteerism**

Students will develop competencies in the development and direction of community volunteer partnerships and collaborations. Students will explore current volunteer development models, collaboration process theory, and key management areas including: visioning, organizing a partnership or collaboration; creating motivating volunteer positions; recruiting, screening, and interviewing; orientation and training; supervising; evaluation; retention and resolution; risk management; and measuring program effectiveness.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

AEE 5304G:**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.

emphasis on agricultural, health, and food system examples. Pre:

Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5754:

Internship in Ag&Extension Ed

Student participation in a planned clinical experience under supervision of a university faculty member in an approved, appropriate professional setting. A written Internship Agreement must be completed and approved before the internship begins.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5764:

Externship in AEE

Students participate in a special interdisciplinary problem-solving approach for experienced agricultural education and extension professionals who are engaged in part-time graduate study while continuing in positions of leadership. Interdisciplinary teams of faculty work with small groups of experienced professionals in systematic analysis of contemporary issues. Students are judged on quality of their investigations, individual reports, and delivery of subject matter.

(Maximum 12C). Consent required.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5804:

Scientific Procedures in Agricultural and Extension Education

Principles, practices, and strategies for conducting research in the social sciences, particularly focusing on aspects of the human dimension in the agricultural and life sciences. Research design, instrumentation, data collection and the relationships among these facets of scholarly discovery. Theoretical frameworks, conceptual models, and empirical evidence will be applied to research proposal development. Pre:

Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

AEE 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5964:

Field Study

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

AEE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

AEE 5984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):
Corequisite(s):

AEE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

AEE 6014:

Theoretical Foundations of Non-Formal Learning

Overview of the theory and practice of non-formal learning, emerging paradigms, and historical debates. Development of specific pedagogies based on non-formal learning theories. Education settings and issues relevant to agricultural and extension educators including extension education, community-based education, agriculture training and international development, work place education, and social movements/social activism. Pre: Graduate standing.

Credit Hour(s): 3
Lecture Hour(s): 3
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

AEE 6984:

Special Study

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

AEE 7964:

Field Studies

Credit Hour(s): 1 TO 12
Lecture Hour(s): 1 TO 12
Instruction Type(s): Lecture
Instruction Type(s): Lecture

Prerequisite(s):
Corequisite(s):

AEE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

AGRICULTURAL AND LIFE SCIENCES

James Anderson, Program Director

Professors: Renee Boyer; Walter Daniels; Elizabeth Grabau; Donald Mullins; George Norton; Douglas Pfeiffer; Kerry Redican; Rickie Rudd; Susan Sumner; Gregory Welbaum; Eric Wong;

Associate Professors: Antonius Baudoin; Carlyle Brewster; Matthew Eick; Joseph Eifert; John Galbraith; William Hession; Eric Kaufman; Sally Paulson; Holly Scoggins; Donna Westfall-Rudd; James Westwood; Carl Zipper;

Assistant Professors: James Anderson; Thomas Archibald; Curtis Friedel; Kimberly Niewolny; Hannah Scherer; Matthew Spindler; Robert Williams;

Research Faculty: Cynthia Denbow;

Affiliated Faculty: Margaret Merrill;

Community Viability Chair of Excellence: Rickie Rudd;

General Contact: jcanders@vt.edu

Academic Progress: jjc@vt.edu

Graduate Site: <http://www.cals.vt.edu/online/index.html>

This degree program has been designed for potential students who are place-bound, whether because of professional or family commitments. Courses and the project are arranged to meet the goals of the student. The student selects from a list of six concentration areas: (1) Biosecurity, Bioregulations and Public Health, (2) Education, (3) Environmental Science, (4) Food Safety, (5) Community Leadership, and (6) Plant Science and Pest Management. In addition to course work in the chosen Concentration Area, courses are required from a Core Curriculum.

SPECIAL FACILITIES

This degree program offers flexibility in that most courses are offered asynchronously, allowing work to be completed during a time that is convenient for the individual student. Students must have access to a computer and online resources. High speed access is highly recommended; some course materials may not work smoothly with slower dial up systems.

Agricultural and Life Sciences Facilities

The program is completely web-based and allows students to successfully earn the degree without visiting the Blacksburg campus.

DEGREES OFFERED

MS Degree

Offered In (Virtual)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The student designs a program of at least 30 credits. Nine of these must include courses in the core area. Each student selects 12 credits from the selected concentration area. One course is selected as an elective, generally from another concentration. Six credits are taken in the form of a project with report.

MSLFS Degree

Offered In (Virtual)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The student designs a program of at least 30 credits. Nine of these must include courses in the core area. Each student selects 12 credits from the selected concentration area. One course is selected as an elective, generally from another concentration. Six credits are taken in the form of a project with report.

GRADUATE COURSES (ALS)

ALS 5004:

Animal Nutrition Seminar

Reports and discussion of current research in animal nutrition on an inter-departmental basis. May be repeated. II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5014:

Seminar in Plant Physiology

Formal presentation of principles and concepts in plant physiology.

Review, discussion and critical evaluation of current primary literature and research data. May be repeated. II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5034:

Mathematical Modeling of Metabolic Systems

Techniques used to model nutrient metabolism and associated cellular and systemic responses including compartmental analyses, numerical integration, sensitivity analyses, and parameter estimation. Interpretation and extension of experimental data including isotopic tracers. Prediction of biological responses to nutrient inputs. Pre: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5054:

Methodology in Nutrition Research

Use of laboratory techniques, instrumentation, and experimental design in the solution of fundamental problems in human and animal nutrition.

Odd years. II

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5064 (BIOL 5064) (PPWS 5064) (BCHM 5064):

Seminar in Molecular Cell Biology and Biotechnology

Review and discussion of current problems and literature in molecular cell biology and biotechnology by students, VPI&SU faculty and outside speakers. Students give formal presentations of research results or current literature. May be taken on pass-fail basis. Students enrolled in the MCBB Ph.D. option will be required to give one formal presentation on an A-F basis. Graduate status in participating MCBB departments required. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

492 Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5084:

Advanced Ruminant Nutrition Colloquium

Research papers in nutrition of ruminant animals (beef, dairy, sheep) will be reviewed. Research papers will be selected from scientific journals such as the Journal of Dairy Science, the Journal of Animal Science, the Journal of Nutrition, and Animal Feed Science and Technology. May be repeated (no restriction on number of times). Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5094:

Effective Grant Writing for the Biomedical and Behavioral Sciences

The grant writing process and developing student skills for successful grant writing to support research enterprises. Students will prepare a mock research grant proposal for obtaining funds from the National Institutes of Health, National Science Foundation, or the US Department of Agriculture and participate in panel review of grant proposals of peers.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): APSC 5004 OR (ALS 5064 OR BIOL 5064 OR BCHM 5064 OR PPWS 5064)

Corequisite(s):

ALS 5105:

Population Genetics

Principles of population genetics; gene frequency; forces that change gene frequency (migration, mutation, selection); genetic drift; biometric relationships between relatives; calculation of inbreeding and relationship; additive, dominance, and epistatic effects; estimation and use of repeatability, heritability, and genetic correlations; and formation and use of selection goals and selection criteria. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): STAT 5615, STAT 5616

ALS 5106:

Population Genetics

Principles of population genetics; gene frequency; forces that change gene frequency (migration, mutation, selection); genetic drift; biometric relationships between relatives; calculation of inbreeding and relationship; additive, dominance, and epistatic effects; estimation and use of repeatability, heritability, and genetic correlations; and formation and use of selection goals and selection criteria. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s): STAT 5615, STAT 5616

ALS 5115:

Nutrition

Digestion, absorption and metabolism of nutrients in animals including humans. Digestive physiology; digestion and absorption; bioenergetics; and carbohydrate and lipid metabolism with emphasis on substrate sources, interrelationships, and factors affecting utilization and metabolism. Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5116:

Nutrition

Digestion, absorption and metabolism of nutrients in animals including humans. Absorption, metabolism and function with emphasis on physiological and biochemical aspects of protein, amino acid, vitamins, and minerals; epidemiological, biochemical, cellular or molecular methodologies useful for study of macronutrients and micronutrients and their biological functions also will be covered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ALS 5115

Corequisite(s):

ALS 5144:**Molecular Aspects of Nutrition and Disease**

The role of specific nutrients in human and animal health at a physiologic and molecular level. Emphasis is placed on the influence of nutrients on gene expression especially with regard to pathophysiology of diseases.

Physiological and molecular aspects of nutrition and immune function will also be discussed. Even years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5124 (UG) OR BCHM 5124, (ALS 5104 (UG) OR ALS 5104 OR HNFE 5104 (UG) OR HNFE 5104)

Corequisite(s):

ALS 5204:**Research and Information Systems in the Life Sciences**

A focus on research techniques and processes for life science professions. Topics include: history of applied life sciences, current structure of the scientific enterprise, the scientific method and quality assurances, researching the literature, scientific writing and presentation of research results, instructional techniques, professionalism, and ethical considerations. Information technology is employed throughout the course. Students learn to use digital technologies for communication, presentation, and publication.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ALS 5214:**Information Systems and Research in the Life Sciences**

Research techniques and processes used in the life science professions. History of applied life sciences, structure of the scientific enterprise, the scientific method and quality assurances, researching the literature and critically evaluating information, scientific writing and communication of research results, professionalism, and ethics. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ALS 5234G:**Adv Concepts Comm Food Systems**

Examination of the economic, political, social, and cultural issues related to community food systems and agricultural practices. Topics include local and regional food systems development, food production and biotechnology, food sovereignty and security, and population and environmental health. Analysis of models, strategies, and policies of national food systems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5304:**Advanced Physiology and Anatomy of Domestic Animals**

Mammalian physiology and anatomy will be evaluated in domestic animals, laboratory animals, and primates. Emphasis will be on the cardiovascular, renal, respiratory, neural, muscle, and digestive physiology. I

Credit Hour(s): 0 OR 5

Lecture Hour(s): 0 OR 4

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ALS 2304 (UG) OR ALS 2304

Corequisite(s):

ALS 5314:**Comparative Reproductive Physiology**

Comparative mechanisms of all major aspects of male and female reproductive physiology will be examined in domestic animals, laboratory animals, and primates. Emphasis will be given to species variation in regard to reproductive function and to a detailed examination of key reproductive events in both sexes. II

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): ALS 4304 (UG) OR ALS 4304

Corequisite(s):

ALS 5324:**Research Ethics in Agriculture and Life Sciences**

Principles of and skills development in research ethics to enhance professional preparation in agriculture and life sciences. Pre: Graduate

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ALS 5334:

Professional Communication Agriculture & Life Sciences

Principles of, and skill development in, academic communication to enhance professional preparation in the agricultural and life sciences.

Pre: Graduate standing.

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ALS 5405:

Analysis of Animal Experiments with SAS

5405: Organization and management of data from animal experiments using Excel, JMP, and SAS. Emphasis on maintenance of data integrity and creation of datasets for statistical analyses, including formats, unit conversions, date and string functions, concatenation and merges, import and export data, and simple statistics. 5406: Use of Statistical Analysis System (SAS) procedures to analyze data from animal experiments. Topics covered will include SAS strategies and options for exploratory statistics, regression, ANOVA, mixed models, and repeated measures from several designs. Graduate standing required.

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s):
Corequisite(s):

ALS 5406:

Analysis of Animal Experiments with SAS

5405: Organization and management of data from animal experiments using Excel, JMP, and SAS. Emphasis on maintenance of data integrity and creation of datasets for statistical analyses, including formats, unit conversions, date and string functions, concatenation and merges, import and export data, and simple statistics. 5406: Use of Statistical Analysis System (SAS) procedures to analyze data from animal experiments. Topics covered will include SAS strategies and options for exploratory statistics, regression, ANOVA, mixed models, and repeated

measures from several designs. Graduate standing required.

Credit Hour(s): 2
Lecture Hour(s): 2
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): ALS 5405, (STAT 5605 OR STAT 5615)
Corequisite(s):

ALS 5504:

Quantitative Genetics Applications of Matrix Algebra

Tools in quantitative genetics utilized for describing and solving problems in the agriculture and life science, with particular focus on matrix algebra. Utilize matrix algebra into genetic application, conduct matrix operations, identify the determinant and inverse of a matrix, determine linear independence, dependence and rank, use linear equations, generalized inverse, and latent roots and vectors to solve complex issues in advanced quantitative genetics. Graduate standing required.

Credit Hour(s): 1
Lecture Hour(s): 1
Instruction Type(s): Lecture, Online Lecture
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): ALS 5304
Corequisite(s):

ALS 5904:

Project and Report

Credit Hour(s): 1 TO 19
Lecture Hour(s):
Instruction Type(s): Research
Instruction Type(s): Research
Prerequisite(s):
Corequisite(s):

ALS 5954:

Study Abroad

Credit Hour(s): 1 TO 19
Lecture Hour(s): 1 TO 19
Instruction Type(s): Lecture
Instruction Type(s): Lecture
Prerequisite(s):
Corequisite(s):

ALS 5964:

Field Study

Credit Hour(s): 1 TO 12
Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ALS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ALS 6024:

Topics in Molecular Cell Biology and Biotechnology

Specific areas such as the molecular biology of plant and animal disease resistance, of photosynthesis, of oncogenes, of organelle assembly, and of growth and development, structure and function of polyamines and of proteases will be discussed. Students will give presentations and critically analyze current literature. May be repeated. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5214 (UG) OR BCHM 5214

Corequisite(s):

ALS 6314:

Endocrinology

Hormones produced in animals and their roles in development, growth, appetite, digestion, metabolism, lactation, reproduction, homeostasis, and behavior. Mechanisms by which hormones act and the factors that regulate the production and action of hormones. Endocrine disorders and hormone-based application in medicine and animal agriculture. major methodologies in current endocrine research.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (ALS 5304 (UG) OR ALS 5304) OR ALS 5344

Corequisite(s):

ALS 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ALS 7964:

Field Studies

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ANIMAL AND POULTRY SCIENCES

David Gerrard, Head

Professors: Donald Denbow; Mark Estienne; David Gerrard; Scott Greiner; Honglin Jiang; James Knight; Mark McCann; Edward Smith; Eric Wong;

Associate Professors: Rami Dalloul; Alan Ealy; Joseph Eifert; Dan Eversole; Sally Johnson; Robert Rhoads; Rebecca Splan; Cynthia Wood;

Assistant Professors: Mark Cline; Benjamin Dorshorst; Samer El-Kadi; Elizabeth Gilbert; Kiho Lee; Michael Persia; Michelle Rhoads;

John W. Hancock, Jr., Professor of Animal Science: Eric Wong;

Paul Mellon Distinguished Chair of Agriculture: Sally Johnson;

General Contact: sealy@vt.edu

Student Handbook: <http://www.apsc.vt.edu>

The Department of Animal and Poultry Sciences at Virginia Tech offers the M.S. and Ph.D. degrees. Students may specialize in the areas of genetics, genomics, immunology, management, molecular biology, muscle biology, nutrition, physiology, and product quality assurance. M.S. students may also specialize in the area of livestock or poultry management. Interdisciplinary and interdepartmental programs are encouraged and students are given wide latitude to develop customized programs of study directed toward specific career goals. The department has 36 faculty members who serve the needs of about 500

undergraduate and about 50 graduate students.

SPECIAL FACILITIES

State of the art research laboratories supporting all areas of graduate research are located in Litton Reaves on campus. Livestock facilities are located on the campus, at the nearby Kentland farm and at outlying agricultural research and extension centers across the state. Biosafety Level 2 animal research facilities are located in Litton Reaves on campus. On campus, a 200-ewe sheep flock, a 300-cow beef herd, a 70-sow swine herd, a five-building turkey center with facilities for >2,000 young and 1,500 adult chickens, and a herd of about 25 horses provide resources for teaching and research. The historical Kentland Plantation, 20 miles from campus, provides resources for grazing and animal research. The Shenandoah Valley and Southwest Virginia Agricultural Research and Extension Centers, each 100 miles from campus, provide additional resources for beef cattle forage nutrition and management. The Tidewater Agricultural Research and Extension Center in Suffolk supports an active off-campus program in swine research and extension. The Middleburg Agricultural Research and Extension Center, near Washington, D.C., is the centerpiece for a unique program in equine forage nutrition. Extradepartmental facilities also contribute importantly to the overall program of the Department. These include comprehensive data processing facilities maintained by the Computer Center, an electron microscopy laboratory, DNA sequencing facility, animal health and physiology laboratories in the Virginia-Maryland Regional College of Veterinary Medicine, and embryo manipulation and microinjection facilities for production of transgenic animals in the Department of Dairy Science. The Fralin Biotechnology Center has a shared confocal microscope facility.

Facilities

Livestock facilities The Department manages six livestock centers on-campus and at nearby Kentland Farm, and the Virginia Tech Meat Science Center. Programs also are underway at Agriculture Research and Extension Centers in Middleburg, Shenandoah Valley, Southwest Virginia and Tidewater. Livestock include beef cattle, chickens, horses, sheep, swine and turkeys. **Laboratory facilities** Laboratories include environmental, metabolic, and bio-safety level 2 animal research facilities. University core computing, genomics, proteomics, and metabolomics laboratory facilities are also available. Lab animals include rodents and zebra fish.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Master's Degree. The Department of Animal and Poultry Sciences

allows for both thesis and non-thesis master's degrees. Minimum total graduate credits (5000-level or higher) for thesis option: 30; minimum research credits: 6; minimum graded credit hours: 20. Non-thesis option must include Project and Report: 6 hours minimum; minimum graded graduate credits for non-thesis option: 24. Seminars: minimum 1.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

PhD Degree. Each Ph.D. student must complete a minimum of 90 credit hours of graduate study and a dissertation. Minimum Research and Dissertation hours: 30. Minimum 5000-level or higher graded courses: 27. Seminars: minimum 2. Follow Graduate Catalog procedures.

GRADUATE COURSES (APSC)

APSC 5004:

Graduate Seminar

Students review and lead discussion of current problems and literature in Animal and Poultry Sciences. May be repeated. I,II,III,IV

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

APSC 5044 (PPWS 5044):

Biotechnology in Agriculture and Society

Worldwide impact of biotechnology applied to plants, animals, and microorganisms. Concepts, scientific and ethical issues, and public concerns related to genetic engineering. Safety and release of genetically engineered organisms; bioremediation; cloning; transgenic plants, animals, and microbes. Graduate standing required. Two semesters each of biology and chemistry.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

APSC 5054G:**Advanced Genomics**

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

APSC 5894:**Final Examination**

For non-thesis candidates who are required to register for their final examination and have completed their program of study. Not to be included in minimum hours required for degree. I,II,III

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

APSC 5904:**Project and Report**

Project for non-thesis Master of Science degree. To constitute a maximum of 6 of the 45 hours required for the degree. May be repeated.

I,II,III

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

APSC 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

APSC 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

APSC 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

APSC 6984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

APSC 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BIOCHEMISTRY

Peter Kennelly, Head

Professors: David Bevan; Dennis Dean; Glenda Gillaspay; Peter Kennelly; Timothy Larson; Jianyong Li; Zhijian Tu;

Associate Professors: Richard Helm; Michael Klemba; Biswarup Mukhopadhyay; Pablo Sobrado; Robert White; Jinsong Zhu;

Affiliated Faculty: Carla Finkielstein; James Mahaney; Florian Schubot;

Director, Fralin Life Sciences Institute: Dennis Dean;

General Contact: smearly@vt.edu

Graduate Site: <http://www.biochem.vt.edu/graduate.php>

Student Handbook: http://www.biochem.vt.edu/graduatehandbook2010_final.pdf

The Graduate Program in the Department of Biochemistry at Virginia Tech prepares students for careers as independent researchers in biochemistry, molecular and cellular biology, biotechnology, and related areas. Training involves a combination of advanced course work, participation in seminars and journal clubs and laboratory research conducted under the guidance of a faculty committee selected by students and their faculty advisors. Incoming students participate in three laboratory research rotations to familiarize themselves with faculty and their research. The department has strengths in microbial pathogenesis and infectious disease, cell signaling, proteomics and molecular modeling. The largest cluster of faculty conducts research on infectious diseases with the ultimate aim of developing novel approaches to disease treatment and prevention. Major milestones for students are completion of an oral qualifying examination, an oral preliminary examination which also requires writing an NIH-style research proposal, and writing and defense of a research dissertation. Students also present their research at national and international conferences and participate in more informal training opportunities, including university-wide scientific writing and grant proposal preparation workshops. Our students typically complete their Ph.D.s within five years and pursue a variety of careers including positions in academia, industry and state and federal government.

SPECIAL FACILITIES

Biochemistry is just one facet of a large and vibrant life science research enterprise at Virginia Tech. Our faculty study a range of biochemical problems using cutting edge research equipment and facilities. In collaboration with the Fralin Life Science Institute, our department is home to a proteomics and metabolomics facility. Our students also have access to core facilities for confocal microscopy, fermentation, protein purification, DNA sequencing, flow cytometry, real-time PCR, and microarray analysis. Virginia Tech is known for its interdisciplinary graduate training. Research strengths include infectious disease, obesity, microbial pathogenesis, and eukaryotic cell signaling. Biochemistry students and faculty are active in each of these areas. Students also have opportunities to interact with scientists from across the country and around the world through the interdepartmental Virginia Tech Life Sciences seminar series. The individual laboratories within the department are well equipped for modern biochemical, molecular biological, and microbiological research. Available equipment include a comprehensive suite of mass spectrometers for proteomic analyses, standard and microplate fluorometers, stopped-flow spectrometer with fluorescence excitation for rapid kinetic analysis, UV-visible photodiode array spectrophotometer, a robotic workstation for high-throughput screening, real-time PCR thermocyclers, liquid chromatography systems, systems for electronic autoradiography and fluorescent/chemiluminescent imaging, and tissue culture and insect rearing facilities. Numerous shared on-campus resources enhance the research opportunities available to students. These include the Keck Confocal Microscope Facility, the Keck Transgenic Plant Greenhouse, the Fralin Fermentation and Protein Purification Facility, and the Flow Cytometry Core Facility. Access to NMR spectrometers and X-ray diffractometers is available through the Departments of Chemistry and

Biological Sciences. The Core Computation and Laboratory Facilities at the Virginia Bioinformatics Institute provide a range of bioinformatic, DNA-sequencing, and genomic/proteomic services. The VT CAVE is a multiperson, room-sized, high-resolution, 3-D video and audio environment that can be used to visualize a wide variety of biological molecules in 3-D space.

Biochemistry Facilities

Our students also have access to core facilities for confocal microscopy, fermentation, protein purification, DNA sequencing, flow cytometry, real-time PCR, and microarray analysis. In collaboration with the Fralin Life Science Institute, our department is home to a proteomics and metabolomics facility.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (577.0)

Computer: (233.0)

iBT: (90.0)

GRE

General Test: Verbal (500.0), Quantitative (650.0)

Doctoral students take a set of core courses and at least two specialized courses within their research track during their first two years. Students also complete laboratory rotations (first year) and seminars (all years). Specialized courses are suggested by research track: Vector Borne Disease and Signal Transduction, Protein Structure and Function, and Molecular Microbiology. Students are typically funded by the department during the first three semesters of laboratory rotation. Most students will work as a teaching assistant for two of those semesters. During the non-teaching semester, students are expected to take a higher course load: an additional, specialized required course. Successful Ph.D. candidates must also maintain a cumulative GPA of 3.0 or above in all coursework, and complete the following requirements: - Students must meet all course and research credit hour requirements of the Graduate School. - 27 hours of courses numbered 5000 or higher, may include up to 4 hours of seminar. - Complete a minimum of 90 semester hours of graduate study. - Pass the qualifying examination at the end of the first year. - Pass the preliminary examination at the end of the second year. - Write and successfully defend a research-based dissertation. A complete description of the Academic requirements for Ph.D. Degree is also available in the Graduate Student Handbook.

MSLFS Degree

Offered In (Blacksburg)

TOEFL

Paper: (577.0)

Computer: (233.0)

iBT: (90.0)

GRE

General Test: Verbal (500.0), Quantitative (650.0)

The Graduate Program in Biochemistry is a doctoral degree program. In rare instances, students may earn Masters degrees. M.S. students must take a minimum of 20 hours of coursework (12 credits of 5000-level or higher). Specific course requirements* include Principles of Biochemistry (BCHM 5115-5116, 8 hours), Seminar in Biochemistry (3 hours), Biometry (STAT 5605**) or Statistics in Research (STAT 5615; 3 hours), Information Systems in the Life Sciences (ALS 5984, 3 hours). All students must present a seminar and defend a thesis describing the results of their research as a final step for the completion of M.S. degree requirements. *Substitutions must be approved, in advance, by the student's advisory committee and ratified by the Graduate School. **Recommended

GRADUATE COURSES (BCHM)

BCHM 5004:

Seminar in Biochemistry

Review and discussion of current problems and literature in biochemistry and nutrition. Student presentation of research results, faculty research, and visiting lecturers. May be repeated. Biochemistry majors only. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5014:

Techniques in Biochemical Research

Application of modern biochemical concepts and techniques in research on protein and nucleic acid biochemistry, structure, function, gene expression and organization; microbial metabolism coenzyme biosynthesis; structure and function of membranes and subcellular organelles. Pre-requisite: Graduate standing in Biochemistry. May be repeated once for credit.

Credit Hour(s): 4

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s):

Corequisite(s):

BCHM 5024:

Computational Biochemistry for Bioinformatics

Applications of protein structure and function, protein characterization, enzyme kinetics, and analysis of metabolic control for students with a background in computer science, mathematics, statistics, or engineering.

Pre: B.S or senior standing in computer science, mathematics, statistics, 500

or engineering. Not available to life science majors for credit. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5034G:

Advanced Environmental Health Toxicology

Health effects associated with the exposure to chemicals, identifying and managing problems of chemical exposure in the work place and the environment, fundamental principles of toxicodynamics and toxicokinetics, and risk assessment. Emphasis on conceptual understanding of chemical entry into the body, biotransformation, and elimination from the body. Identification of factors influencing environmental toxicoses and the overall risk to human health and ecological welfare from multiple classes of environmental toxicants.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5054:

Molecular Biology of Prokaryotic Gene Regulation

An analysis of the experimental design and methodology used to elucidate molecular regulation of prokaryotic gene expression. Modern genetic technologies used to identify and characterize these regulatory mechanisms will be emphasized. II. Alternate years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BCHM 4115 (UG), BCHM 4116 (UG)) OR (BIOL 4624 (UG)) OR (BCHM 4115, BCHM 4116) OR (BIOL 4624)

Corequisite(s):

BCHM 5054G:

Advanced Genomics

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. Graduate

standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5064 (BIOL 5064) (ALS 5064) (PPWS 5064):

Seminar in Molecular Cell Biology and Biotechnology

Review and discussion of current problems and literature in molecular cell biology and biotechnology by students, VPI&SU faculty and outside speakers. Students give formal presentations of research results or current literature. May be taken on pass-fail basis. Students enrolled in the MCBB Ph.D. option will be required to give one formal presentation on an A-F basis. Graduate status in participating MCBB departments required. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5115:

Principles of Biochemistry

Comprehensive presentation of principles of protein structure, enzymology, bioenergetics, and metabolism. Relationships between regulatory mechanisms and molecular biology. Current literature on these topics provides emphasis on the relationship of primary scientific literature to biochemical knowledge. Biochemistry majors only. I,II

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 2536 (UG)

Corequisite(s):

BCHM 5116:

Principles of Biochemistry

Comprehensive presentation of principles of protein structure, enzymology, bioenergetics, and metabolism. Relationships between regulatory mechanisms and molecular biology. Current literature on these topics provides emphasis on the relationship of primary scientific literature to biochemical knowledge. Biochemistry majors only. I, II.

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 2536 (UG)

Corequisite(s):

BCHM 5124:

Biochemistry for the Life Sciences

Basic principles of biochemistry including protein structure, enzymology, gene expression, bioenergetics, and pathways of energy metabolism.

Not available to Biochemistry majors. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CHEM 2536 (UG)

Corequisite(s):

BCHM 5204:

Molecular Biology of Eucaryotic Gene Expression

Mechanisms controlling eucaryotic gene expression. Topics include biochemistry and metabolism of DNA and RNA, gene and chromatin structure, enzymology of replication and transcription, modification and processing of RNA, recombinant DNA and molecular cloning techniques.

I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 4116 (UG) OR BCHM 5116 (UG) OR BCHM 4116 OR BCHM 5116

Corequisite(s):

BCHM 5224:

Protein Structure and Function

Structure and function of proteins. Topics include special techniques in protein purification and characterization, techniques for studying protein structure, posttranslational modification of proteins and selected topics to study the structure-function relationship of proteins. Taught alternate years. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BCHM 4115 (UG) OR BCHM 5115 (UG) OR BCHM 5124 (UG)) OR (BCHM 4115 OR BCHM 5115 OR BCHM 5124)

Corequisite(s):

BCHM 5304:**Enzyme Kinetics and Reaction Mechanisms**

Analysis of the mechanisms of enzyme-catalyzed reactions using kinetic and spectroscopic measurements, inhibitors and other chemical probes, or enzyme modification via site-directed mutagenesis. Development and interpretation of kinetic rate equations. Theory and models of enzymatic catalysis. II. Alternate years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BCHM 4115 (UG) OR BCHM 5115 (UG)) OR (BCHM 4115 OR BCHM 5115)

Corequisite(s): BCHM 4116, BCHM 5116

BCHM 5344 (PPWS 5344):**Molecular Biology for the Life Sciences**

A multi-disciplinary treatment of gene organization and expression in animal and plant systems. Emphasis on the applications of molecular biology to current problems in applied biology and biotechnology. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BCHM 4116 (UG) OR BCHM 5124 (UG)) OR (BCHM 4116 OR BCHM 5124)

Corequisite(s):

BCHM 5454:**Biochemistry and Molecular Biology of Anaerobic Organisms**

Contemporary analysis of the biochemistry, genetics, and ecology of strictly anaerobic organisms with emphasis on metabolism as it influences ecological niche and elicits the beneficial and deleterious effects on mankind; techniques to achieve anaerobiosis; role of anaerobic organisms in disease and industrial processes; genome structure of selected anaerobes.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (BCHM 4116 (UG) OR BCHM 5124 (UG) OR BIOL 5634 (UG)) OR (BCHM 4116 OR BCHM 5124 OR BIOL 5634)

Corequisite(s):

BCHM 5784G:**Adv Apps Molecular Life Sci**

Synthesis and application of biochemistry, cell biology, genetics,

genomics, physiology, immunology concepts and techniques to address medical and agrocultural problems. Genre characterization and manipulation, protein-based drugs, diagnostics, vaccines, transgenic plants/animals. Advanced analysis, critique, application of research in molecular life science. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

BCHM 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

BCHM 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BCHM 6004:**Advanced Topics in Biochemistry**

Advanced topics of current interest selected from the current literature.

May be repeated. I

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

502 Instruction Type(s): Lecture

Prerequisite(s): BCHM 5116 (UG) OR BCHM 5116

Corequisite(s):

BCHM 6024:

Topics in Molecular Cell Biology and Biotechnology

Specific areas such as the molecular biology of plant and animal disease resistance, of photosynthesis, of oncogenes, of organelle assembly, and of growth and development, structure and function of polyamines and of proteases will be discussed. Students will give presentations and critically analyze current literature. May be repeated. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5214 OR BCHM 5214 (UG)

Corequisite(s):

BCHM 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CROP AND SOIL ENVIRONMENTAL SCIENCES

Tommy Thompson, Head

Emeriti Faculty: Marcus Alley; Glenn Buss; James McKenna; David Parrish; Raymond Reneau;

Professors: Azenegashe Abaye; Matthew Eick; Erik Ervin; Gregory Evanylo; James Goatley; Carl Griffey; Charles Hagedorn; Steven Hodges; Mohammad Saghai-Maroo; Carl Zipper;

Associate Professors: Duane Berry; John Galbraith; David Holshouser; Rory Maguire; Wade Thomason; Benjamin Tracy; Kang Xia;

Assistant Professors: Brian Badgley; William Frame; Takeshi Fukao;

Research Faculty: Bo Zhang;

W.G. Wyszor Professor: Carl Griffey;

General Contact: saville@vt.edu

CSES website: <http://www.cses.vt.edu>

Graduate programs in the Department of Crop and Soil Environmental Sciences (CSES) lead to both the M.S. (non-thesis and thesis options)

and the Ph.D. degrees. The principal objective of graduate education programs is to educate students in advanced concepts and research methods in one or more subdisciplines of CSES and related programs. This is accomplished through courses and research that bridge a number of physical and biological sciences. Individually planned programs of study are developed to provide training and experience in environmental resource management and control, seed physiology, crop physiology, plant genomics and breeding, plant cell and developmental biology, tissue culture, and molecular genetics, and in the biochemistry, mineralogy, fertility, chemistry, classification, genesis, interpretation, microbiology, and physics of soils. The Department also participates in several interdisciplinary degrees at the M.S. and Ph.D. level.

SPECIAL FACILITIES

The department has extensive facilities, instruments and equipment for many kinds of research and teaching in crop, soil and environmental sciences. Laboratories are instrumented for physiological research on seeds and whole plants; forage quality analyses; for plant cellular/molecular biology, tissue culture, molecular genetics, and breeding research on crop plants; for micro-biological research in water quality, nitrogen fixation and biological control of plant diseases; for modelling research on contaminant movement to ground-water; for soil chemistry and physics research on waste product utilization; for soil testing and plant analysis research on nutrient recycling and on economic inputs in crop production; for soil genesis research relative to land use and soil taxonomy; and for soil mineralogy and physical chemistry research on soil acidity and on thermodynamics and kinetics of anion and cation reactions in soils. In addition to departmental laboratories, traditional agronomic equipment, greenhouses and extensive field facilities at Blacksburg, the Virginia Agricultural Experiment Station has research facilities at twelve locations throughout Virginia. Of particular note are field facilities for grazing research and forage-livestock systems, turfgrass, tobacco, peanut, soybean, corn, and small grains research. Excellent computer and library facilities are available. Also available on campus are electron microscopes, and an electron probe, a mass spectrograph, and facilities for biotechnological research.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal (500.0), Quantitative (500.0), Analytical

Establishing a Committee - The advisor and student will select an Advisory Committee no later than the end of the first semester of residence. The minimum number of members for the advisory committee are 3 for M.S. students, and 4 for Ph.D. students. The Ph.D. committee must have at least one member from outside the Department. At this meeting, the committee will become familiar with the student's training, background, and research interests. The committee also will orient and advise the student regarding research and course-work. Plan of Study: Students are expected to present to their major advisor a draft Program of Study that meets all requirements. After review and approval by the

major advisor, the Plan of Study must be reviewed and approved by all members of the students advisory committee. After approval, the Plan of Study is submitted to the Graduate School through the Student Administration Center in the Department. It is the student's responsibility to see that the Plan Study is submitted to the Graduate School on time (prior to completing 12 credit hours toward the M.S. degree, and before completing 18 credit hours beyond the M.S. toward the Ph.D. degree. Changes to the Plan of Study must be approved by the advisory committee and submitted to the Graduate School through the Student Administration Center. Outline of Proposed Research - As research is initiated for a degree, a Research Proposal will be presented in writing and orally to the student's Advisory Committee. This proposal should include sections containing: (a) an abbreviated literature search; (b) clear and concise objectives; (c) proposed experimental procedures; and (4) data analysis and presentation procedures. The purpose of this requirement is to determine whether the research proposed is adequate to satisfy degree requirements and to assist the student in clarifying objectives and procedures. The time to present the proposal should be determined by the major advisor and the committee. Students are encouraged to begin this process as soon as possible in order to complete their studies in a timely manner and with minimal wasted efforts! Report on Research - Each graduate student will present an annual progress report (one page maximum) to his/her Advisory Committee and other interested persons prior to the final examination. The purpose of such reports is to evaluate the research progress and make suggestions for modifications or additions to the research objectives or procedures. A copy of the report is to be provided to the Graduate Coordinator. Preliminary Examination - Candidates for the Ph.D. degree should schedule the Preliminary Examination at an early date. This will allow the student time to take courses that the Advisory Committee may require to correct deficiencies. The preliminary examination must be taken at least nine months before graduation and prior to completing 2/3 of the required work (course work and/or research) for the degree. Preparation of Theses/Dissertations or Non-Thesis M.S. Project Reports - The student, with the assistance of his or her major professor, has the responsibility for preparation of the thesis/dissertation/project report. While the Graduate School specifies certain formats, it leaves matters of style largely to departments, but urges that the style conform to the major professional or scientific journals in the student's area of interest. Therefore, the CSES Department suggests that theses/dissertations/project reports follow the style of journals of the American Society of Agronomy or other sources acceptable by the committee. Students may find that certain mechanical considerations for manuscripts will differ between ASA's and those specified by the Graduate School. Follow the Graduate Policies and Procedures in such cases. Preparation of the thesis/dissertation/project report in proper style will facilitate the preparation of manuscripts for publication. All theses and dissertations must be submitted to the Graduate School in electronic format. Seminars are given by the Graduate School each semester to familiarize students with the procedures needed to prepare the electronic submission. Students are expected to know these procedures and prepare the thesis or dissertation to meet all requirements. Each section of the thesis/dissertation/project report should be prepared to the satisfaction of the Major Professor before being given to the other members of the Advisory Committee for review. Each section is to be provided to the committee members as it is completed. All sections of the thesis/dissertation are to be reviewed by the committee at least 30 days prior to the examination. Students will provide the members of the Advisory Committee the complete and revised thesis/dissertation at least 10 days prior to the oral examination/defense. Even though each member of the Advisory Committee will have provided suggestions or requirements for revisions of the thesis/dissertation/project report prior to

the final examination, some corrections or additions will always be necessary even following a successful final examination. The Graduate School allows a period of two weeks after the final examination to submit the final version of the thesis or dissertation. The final project report is submitted only to the Major Advisor and Advisory Committee. Foreign Language Requirement - The department does not require a foreign language for any degree.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal (400.0), Quantitative (500.0), Analytical

Establishing a Committee - The advisor and student will select an Advisory Committee no later than the end of the first semester of residence. The minimum number of members for the advisory committee are 3 for M.S. students, and 4 for Ph.D. students. The Ph.D. committee must have at least one member from outside the Department. At this meeting, the committee will become familiar with the student's training, background, and research interests. The committee also will orient and advise the student regarding research and course-work. Plan of Study: Students are expected to present to their major advisor a draft Plan of Study that meets all requirements. After review and approval by the major advisor, the Plan of Study must be reviewed and approved by all members of the students advisory committee. After approval, the Plan of Study is submitted to the Graduate School through the Student Administration Center in the Department. It is the student's responsibility to see that the Plan of Study is submitted to the Graduate School on time (prior to completing 12 credit hours toward the M.S. degree, and before completing 18 credit hours beyond the M.S. toward the Ph.D. degree. Changes to the Plan of Study must be approved by the advisory committee and submitted to the Graduate School through the Student Administration Center. Outline of Proposed Research - As research is initiated for a degree, a Research Proposal will be presented in writing and orally to the student's Advisory Committee. This proposal should include sections containing: (a) an abbreviated literature search; (b) clear and concise objectives; (c) proposed experimental procedures; and (4) data analysis and presentation procedures. The purpose of this requirement is to determine whether the research proposed is adequate to satisfy degree requirements and to assist the student in clarifying objectives and procedures. The time to present the proposal should be determined by the major advisor and the committee. Students are encouraged to begin this process as soon as possible in order to complete their studies in a timely manner and with minimal wasted efforts! Report on Research - Each graduate student will present an annual progress report (one page maximum) to his/her Advisory Committee and other interested persons prior to the final examination. The purpose of such reports is to evaluate the research progress and make suggestions for modifications or additions to the research objectives or procedures. A copy of the report is to be provided to the Graduate Coordinator. Preliminary Examination - Candidates for the Ph.D. degree should schedule the Preliminary Examination at an early date. This will allow the student time to take courses that the Advisory Committee may require to correct deficiencies. The preliminary examination must be taken at least nine months before graduation and prior to completing 2/3 of the required work (course work and/or

research) for the degree. Preparation of Theses/Dissertations or Non-Thesis M.S. Project Reports - The student, with the assistance of his or her major professor, has the responsibility for preparation of the thesis/dissertation/project report. While the Graduate School specifies certain formats, it leaves matters of style largely to departments, but urges that the style conform to the major professional or scientific journals in the student's area of interest. Therefore, the CSES Department suggests that theses/dissertations/project reports follow the style of journals of the American Society of Agronomy or other sources acceptable by the committee. Students may find that certain mechanical considerations for manuscripts will differ between ASA's and those specified by the Graduate School. Follow the Graduate Policies and Procedures in such cases. Preparation of the thesis/dissertation/project report in proper style will facilitate the preparation of manuscripts for publication. All theses and dissertations must be submitted to the Graduate School in electronic format. Seminars are given by the Graduate School each semester to familiarize students with the procedures needed to prepare the electronic submission. Students are expected to know these procedures and prepare the thesis or dissertation to meet all requirements. Each section of the thesis/dissertation/project report should be prepared to the satisfaction of the Major Professor before being given to the other members of the Advisory Committee for review. Each section is to be provided to the committee members as it is completed. All sections of the thesis/dissertation are to be reviewed by the committee at least 30 days prior to the examination. Students will provide the members of the Advisory Committee the complete and revised thesis/dissertation at least 10 days prior to the oral examination/defense. Even though each member of the Advisory Committee will have provided suggestions or requirements for revisions of the thesis/dissertation/project report prior to the final examination, some corrections or additions will always be necessary even following a successful final examination. The Graduate School allows a period of two weeks after the final examination to submit the final version of the thesis or dissertation. The final project report is submitted only to the Major Advisor and Advisory Committee. Foreign Language Requirement - The department does not require a foreign language for any degree.

GRADUATE COURSES (CSES)

CSES 5004:

Graduate Seminar

Lectures and discussions by faculty and graduate students on current research topics in the areas of crop science, soil science and environmental quality. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CSES 5064:

Turfgrass Science Seminar

Critical review of current journal articles addressing research topics in

turfgrass physiology, ecology, cultural programming, pathology, entomology, and weed science. Pre-requisite: Graduate Standing required.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CSES 5114:

Soils for Professionals

Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertility, plant growth, land-use management, waste application, soil and water quality, and food production. Calculations used in land-use management. Pre: One year of introductory biology and chemistry. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CSES 5124:

Topics in Soil Genesis

Topics in soil genesis of regional interest will be addressed. This is a one-week field course that will rotate each year among four regions in the northeastern United States. The regions are Virginia-Maryland, Pennsylvania-West Virginia, New York, and the New England states. This will provide students the opportunity to observe and study soils in the field over a much broader geographic area that otherwise is not possible in a conventional semester course. May be repeated. III

Credit Hour(s): 1

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s): CSES 4134 (UG) OR CSES 4134

Corequisite(s):

CSES 5214:

Soil-Plant Relationships

An interdisciplinary study of soil-plant relationships, with particular emphasis placed on soil chemical and physical properties and their influence on plant growth and development. Topics studied include: root growth, soil compaction, water in the soil-plant-atmosphere continuum,

soil acidity, nutrient movement to plant roots, soil aeration, and nitrogen in the soil-plant environment. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CSES 4214 (UG) OR CSES 4214

Corequisite(s):

CSES 5304 (HORT 5304):

Advanced Plant Genetics and Breeding

Plant breeding theory and methodology for the improvement of argonomic and horticultural crops; genetic diversity; polyploidy; gene inheritance, expression, interaction, and stability; incompatibility; male sterility; haploidy; genetic engineering and transformation; parental selection, hybridization, and population development; breeding methods, genotypic and phenotypic line selection and evaluation; strategies for cultivar development including marker assisted selection and breeding for durable disease resistance. Graduate standing required.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CSES 4144 (UG) OR CSES 4144 OR BIOL 2004 (UG) OR BIOL 2004

Corequisite(s):

CSES 5344:

Advanced Crop Physiology

Physiological considerations in a crop community: light interception, gas exchange, water stress, flowering, and senescence; key metabolic processes that most directly affect yield: photosynthesis (C3 and C4), photorespiration, and N-metabolism; cropping systems as symbioses. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CSES 4344 (UG) OR CSES 4344

Corequisite(s):

CSES 5544:

Soil-plant-animal Interrelationships in Grasslands

The principles of plant competition and succession during the establishment and maintenance of herbaceous species and communities are interrelated to soil, biotic, and microclimatic factors and their interactions. Ecological and nutritional principles embodying plant and animal factor in the utilization of herbaceous plants by livestock are

established. Research methodology in grassland systems is presented.

II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CSES 4214 (UG), CSES 4544 (UG), ALS 3204 (UG)) OR (CSES 4214, CSES 4544, ALS 3204)

Corequisite(s):

CSES 5554:

Ecology of Grazing Land Systems

A multi-disciplinary, multi-institution, field course. Students travel through diverse ecosystems studying the components and functions of grazing lands. Attention is to: (a) how components and functions vary to ecoregion; (b) research needs, objectives, and techniques in soil-plant-animal research; (c) forage-livestock ecology and systems in crop-, pasture-, range-, and forestlands; (d) the role of forages in conservation, wildlife habitat, and sustainable agriculture; and (e) industries involved with forages and livestock. given to: (a) how components and functions vary by ecoregion; (b) research needs, objectives, and techniques in soil-plant-animal research; (c) forage- livestock ecology and systems in crop-, pasture-, range-, and forestlands; (d) the role of forages in conservation, wildlife habitat, and sustainable agriculture; and (e) industries involved with forages and livestock. X grade applies.

Credit Hour(s): 3

Lecture Hour(s): 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CSES 4544 (UG) OR CSES 5544 (UG) OR CSES 4544 OR CSES 5544

Corequisite(s):

CSES 5604:

Environmental Science Concepts for Professionals

Physical, chemical, and biological principles and processes that are central to human-environment interactions. Emphasizes air and water resources and the role of energy in human and natural systems. Major U.S. environmental legislation and regulations. Pre: Two semesters each of college chemistry and biology and one semester of economics. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CSES 5634:**Soil Chemistry**

Chemical and colloidal properties of clays and organic matter in soil systems including ion exchange, retention and precipitation; soil acidity and salinity; mineral weathering and formation; oxidation-reduction reactions; trace and toxic elements, and organic pollutants in soils. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (CSES 3114 (UG), CSES 3124 (UG)) OR (CSES 3114, CSES 3124)

Corequisite(s):

CSES 5644:**Advanced Soil Waste Management Systems**

Design and management of soil-landscape systems for beneficial utilization or disposal of organic and inorganic wastes and process residuals. Fundamentals of soil site and waste characterization, risk assessment, soil and water monitoring protocols, laboratory analysis and vegetation interactions. Regulations and permitting for various land application systems including biosolids, coal combustion products, composting, dredge spoils, manures, papermill aludges, conventional and alternative septic systems, and wastewater irrigation. May not be taken after CSES 4644. Mandatory 3-day field trip and field project.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CSES 5114

Corequisite(s):

CSES 5674:**Atmospheric Pollution**

Analysis of practical problems related to pollution of the earth's atmosphere. Atmospheric structure, applications of the ideal gas law, ambient air quality standards, odor and visibility, pollutant scavenging processes, physical mechanisms controlling global winds, vertical mixing, and atmospheric stability. Gaussian plume models for pollutant dispersion in the atmosphere. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CSES 5694:**Soil Biochemistry**

Comprehensive presentation and analysis of the biochemistry of soil humic acid formation, physicochemical properties of humic substances, and interactions of soil humic substances with toxic organics and metals. Microbial degradation of organics, including pesticides, and the fate of genetically engineered microbes in soil. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (CSES 4684 (UG), CSES 4694 (UG), BIOL 4684 (UG)) OR (CSES 4684, CSES 4694, BIOL 4684)

Corequisite(s):

CSES 5734:**Clay Mineralogy**

Structure, composition, classification, identification, and properties of clay minerals; emphasis on characteristics of mixed-phase systems in sediments and soils. II

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CSES 5634 (UG) OR GEOS 3504 (UG) OR CSES 5634 OR GEOS 3504

Corequisite(s):

CSES 5744G:**Adv Managed Ecosys Serv & Sust**

Interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, energy, water, recreation, and other essential ecosystem services. Models of ecosystem development, role of disturbance, application of ecological theory and concepts to agricultural, grassland, and urban/turf ecosystems. Regional and global significance in sustainable food systems, and global ecosystem assessment. Pre-requisite: Graduate Standing and knowledge of basic soil science required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Advanced Bioremediation

Environmental biotechnology and use of microbes and other organisms to remove contaminants and improve environmental quality. Treatment of contaminated soils, waters, and wastewaters; remediation of industrial waste streams. Current topics and future directions in biodegradation research. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

CSES 5774:

Advanced Rehabilitation of Disturbed Lands

Advanced study of human disturbance of soils and landscapes and various remediation strategies. Global environmental impacts of coal and metal mining, mineral processing, highway-utility corridor development, and urbanization. Acid mine drainage and treatment, including use of artificial wetlands. Study tours and field project. May not be taken after CSES 4774 or CSES 5874. Graduate standing required.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): CSES 4124 (UG) OR CSES 4124 OR CSES 4134 (UG) OR CSES 4134 OR MINE 4544 (UG) OR MINE 4544

Corequisite(s):

CSES 5844:

Plant Genomics

Comprehensive overview of genomics and its applications. Topics include: molecular markers, map construction, map-based cloning, quantitative trait loci, and functional genomics. Even Years. Pre: Knowledge of general principles of genetics and molecular biology. I.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): CSES 4144 (UG) OR CSES 4144

Corequisite(s):

CSES 5854:

Advanced Wetland Soils

Wetlands 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 wetland soils are mandatory. Pre: Graduate standing.

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): null null

Corequisite(s):

CSES 5864:

Advanced Wetland Soils and Mitigation

Wetland soils as components of natural landscapes and their interactions with hydrologic systems. Hydric soil identification and delineation, preparation of wetland water budgets, restoration of damaged wetlands, and creation of compensation wetlands. Utilization of advanced soil information systems and GIS/GPS in wetlands study. Constructed wetlands for nutrient removal and acid mine drainage treatment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CSES 5114 (UG) OR CSES 5114

Corequisite(s):

CSES 5874:

Reclamation of Disturbed Lands

Human disturbances of soils and landscapes and various remediation strategies. Environmental impacts of coal and metal mining, mineral processing, highway or utility corridor development, and urbanization. Field and lab testing protocols; development of site-specific revegetation protocols. Acid mine drainage and treatment, including use of artificial wetlands.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): CSES 5114

Corequisite(s):

CSES 5904:

Project and Report

Project for non-thesis Masters of Science degree option. To constitute 3 to 6 of the 30 credit hours required for the degree. This course will emphasize critical interpretation, review, and oral/written reporting of an

assigned topic. Review grade only. May be repeated. I,II,III

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

CSES 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

CSES 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lab, Lecture, Online Lecture

Instruction Type(s): Lab, Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

CSES 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

CSES 6634:

Soil Physical and Colloidal Chemistry

Rigorous theoretical and applied treatments of soils and molecular adsorption, desorption, distribution, and exchange from soil colloidal systems. II

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): (CSES 5634 (UG), CHEM 4616 (UG)) OR (CSES 5634, CHEM 4616)

Corequisite(s):

CSES 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

DAIRY SCIENCE

Robert Akers, Head

Professors: Robert Akers; Mark Hanigan; Robert James; Katharine Knowlton;

Associate Professors: Benjamin Corl; Isis Kanevsky; Christina Petersson-Wolfe;

Assistant Professors: Rebecca Cockrum; Gonzalo Ferreira;

Horace E. and Elizabeth F. Alphin Professor: Robert Akers;

David R. and Margaret Lincicome Professor of Agriculture: Mark Hanigan;

Colonel Horace E. Alphin Professor: Katharine Knowlton;

General Contact: isisk@vt.edu

Student Handbook: <http://www.dasc.vt.edu>

The GRE exam is required for all applicants. The results of the Test of English as a Foreign Language (TOEFL) is required for applicants who did not receive their bachelor's degrees from an Anglophone university and whose first language is not English. A minimum TOEFL score of 550 (paper based test) or 213 (computer based test) is required. Three letters of recommendation are required. We strongly encourage applicants to have online recommendations completed. You will be asked to provide names and email addresses for each of your references in your online application. If applicants choose to have paper letters of recommendation submitted, the letters should be sent to the attention of Becky Michael in the Dairy Science Department. It is expected that applicants should be near completion of a B.S. or M.S. degree in animal or dairy science, biology, microbiology, biochemistry, related biological fields, agricultural economics, or agricultural finance. Students should have a 3.0 GPA or greater and strong scientific writing and communication skills. Students are strongly encouraged to apply online. Applying online streamlines the application process and reduces processing time. Applicants must pay a \$65 non-refundable fee. IntroductionThe Dairy Science Department recognizes the significant contributions made by graduate students to departmental research, teaching, and extension programs and is committed to providing the best possible opportunity for students to learn and develop as professionals in their areas of interest. The primary purpose of this guide is to outline policies specific to the Dairy Science Department at Virginia Tech. Policies of the Graduate School are documented in the Graduate Catalog available from the Graduate School or on-line through links via the Virginia Tech Home Page (www.dasc.vt.edu). Terms of EmploymentMany graduate students in Dairy Science receive financial support in the form of a graduate research assistantship or graduate

teaching assistantship. Since all students conduct research as a part of degree requirements and most students assist in some way with the teaching of classes, the Department of Dairy Science makes no meaningful distinction between graduate research and teaching assistantships. Some students are recipients of fellowships awarded through the College, University, or Graduate School, and a few are supported by their own funds or funds from their home country, in the case of some international students. Regardless of the source or amount of support, all graduate students are considered to be half time employees of the department. As such, graduate students are expected to work 20 hours per week (50 weeks per year with two weeks paid vacation) in support of departmental research, teaching, and/or extension programs. Much of this is related to the thesis or dissertation research conducted by all students and is heavily concentrated in the latter stages of a student's degree program. However, graduate students also are expected to contribute to departmental research projects, assist in classroom teaching, and participate in extension programs as requested by their faculty supervisors, to whom they are directly responsible. Participation in departmental research, teaching and extension activities serves not only to support departmental programs, but also to train students in areas important to eventual career success.

SPECIAL FACILITIES

Laboratories

The Department resides in Litton Reaves Hall, a modern, well equipped, office building. In addition to offices, it includes extensive laboratory with state of the art equipment and classroom facilities designed to support dairy research, teaching, and extension programs. Computing facilities are available in the building, at various campus locations, and at the University Computing Center (IBM SP2, SGI Origin 2000, Supercomputer access). The Department maintains a research and teaching herd of 150 milking cows (Holsteins and Jerseys) in a dairy center less than one mile from the office building.

Virginia Tech Dairy

The Virginia Tech Dairy Cattle Center, located on 600 acres of land at the southwest edge of campus, maintains over 400 head of dairy animals in both conventional and a new free-stall cattle housing unit. The complex includes a milking parlor, calf barn, bull barn complete with semen collection area, and other facilities for feed storage, etc. At our current on campus farm, the principle structure is a teaching and research freestall barn for approximately 250 cows, with an attached milking parlor. The freestall area is industry standard with the built-in ability to house animals in relatively small groups for teaching and research use, and the addition of self locking head gates and a drover's alley. Additionally, our herd is currently the only one in the nation with both AFILab and Pedometer Plus systems.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

Graduate Advisory Committee All students are assigned a faculty supervisor (major professor) prior to, or immediately after initial enrollment. Assignments should be mutually agreeable to both student and faculty member, and each faculty supervisor should have an active research program in the area of student interest. Within the first or second semesters of enrollment, each student should work with his/her faculty supervisor to establish an advisory committee (three members for MS committees; four for Ph.D. committees) to assist in the development of a program of study and completion of the thesis or dissertation research project. Advisory Committee members are expected to provide appropriate and timely input to the academic and research programs of the student. Conversely, both students and faculty supervisors are expected to assure appropriate involvement of the advisory committees in each student's program. Students should discuss any problems related to their advisory committee with their faculty supervisor and, if needed, with the department head. Credit Hour Loads Full-time credit hour loads are 12 hours in Fall and Spring semesters (in addition to courses audited). Typically, students will register for 6 to 9 hours of formal course work (2 to 3 classes) during Fall and Spring terms (or less during the latter stages of a graduate program), and for sufficient hours of Research and Thesis (MS) or Research and Dissertation (PhD) credits to complete the 12-hour, full-time load. Note that this is required for payment of assistantships and for progression from assistantship step 1 to step 2, since step 2 requires the completion of 24 credit hours. Students who, prior to the beginning of a semester, will have 1) fulfilled all residency and course requirements 2) scheduled their final exam to take place within the first 20 class days of the term and 3) have their thesis/dissertation ready for defense by the start of the semester, are eligible to request registration for 1 hour as a Defending Student (exceptions to the 20 day rule may be granted by the Graduate School). A certification form, available from the departmental office, must be submitted to the Graduate School in order to be registered as a Defending Student. Registration as a Defending Student may affect eligibility for assistantships and certain student benefits and/or loans since students so registered do not pay the comprehensive fee and are not classified as full-time students. Evaluation of Performance and Progress toward Degree In an effort to foster communications between graduate students, their faculty supervisors, and advisory committees, the Dairy Science Department requires an annual evaluation and communication of graduate student performance and progress toward either the M.S. or Ph.D. degree. The process is initiated with a written report, from each graduate student to his/her faculty supervisor, which appropriately details the graduate student's academic and research program progress during the preceding year. The form of the report is the prerogative of the faculty supervisor and due by February 1st of each year or earlier as designated by the faculty supervisor. In response, faculty supervisors will, by March 1st of each year, write a letter which details the supervisor's evaluation of each graduate student's performance and progress toward a degree. Graduate students and faculty supervisors should meet at an appropriate and convenient time to discuss the student's report and supervisor's evaluation, concentrating most especially on any differences in expectations or evaluation between the student and supervisor. Both the student's report and supervisor's letter will become a part of the student's file. It is expected that advisory committee members will be used appropriately to develop

each student's academic program, in the planning and execution of the research project, and in contributing to the evaluation letter. We have recently produced a form that serves to more clearly define guidelines and requirements. Briefly, students must be registered for the minimum of three credits in the semester/summer they take an examination or when a degree is completed. If a dissertation is ready for defense by the beginning of a semester (See http://www.grads.vt.edu/academics/dates_deadlines/commencement_deadlines.html for the deadlines for each semester of the current year) the student may qualify for Defending Student Status (DSS, 1 credit; http://www.grads.vt.edu/graduate_catalog/poli/UIPo.jsp?p=11). To assist you and your advisor, the department has created a Graduate Student Progress Check List and the Annual Graduate Student Evaluation Form. These are included at the end of this document. Time Limits for Degree Programs Guidelines for time to complete graduate degree programs are established as departmental policy in the interest of both the department and student. As a general guideline, it is expected that MS programs will be completed within two years and that Doctoral programs will require no more than three years. Students receiving financial assistance are assured of continuing support for these periods of time. In the event that circumstances prevent completion of a degree within the prescribed time limit, it is the responsibility of the student's faculty supervisor to request or provide an extension of financial support. Annual Evaluation Guidelines There are two new forms that will become part of your student record in the department. The first is a DASC Graduate Student Checklist and the second is a DASC Annual Student Evaluation Form. So you will know what is expected copies of these forms are also included as the end of this document. Copies of the forms (saved as word documents) have also been sent to your major professor and to you and are available from Becky Michael as well. The annual evaluation of graduate students provides an opportunity to insure that appropriate progress toward degree requirements is occurring and to allow for adjustments in the program of study, teaching activities, or research efforts. Clearly, it is also important to keep the advisory committees informed. Remember your advisory committee is not likely to seek you out. It is your responsibility to use your advisory committee effectively. These members can provide excellent insight, perspective, and encouragement but only if you engage them. Since the evaluations occur in the Spring Semester (see above) - to meet pending graduate school requirements -- your first evaluation may well be rather brief. However, the following elements are expected to be part of your evaluation documentation as appropriate. Signatures of the Major Advisor and Committee Members (likely not applicable during your first evaluation cycle). Milestones accomplished - for example, filing of the program of study or scheduling of the preliminary exam (for a Ph.D. student). Documentation indicating that a regular meeting of the student advisory committee was held and a brief written summary of major conclusions from the meeting (may not apply with initial evaluations). List of publications. List of professional talks. Documentation of teaching activities. Listing of service activities. Awards and other honors. General academic progress - i.e. satisfactory progress in class work as well as research activities. Comments by the student Signature of Student - to indicate that her or she read and understands the document

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

Graduate Advisory Committee All students are assigned a faculty supervisor (major professor) prior to, or immediately after initial enrollment. Assignments should be mutually agreeable to both student and faculty member, and each faculty supervisor should have an active research program in the area of student interest. Within the first or second semesters of enrollment, each student should work with his/her faculty supervisor to establish an advisory committee (three members for MS committees; four for Ph.D. committees) to assist in the development of a program of study and completion of the thesis or dissertation research project. Advisory Committee members are expected to provide appropriate and timely input to the academic and research programs of the student. Conversely, both students and faculty supervisors are expected to assure appropriate involvement of the advisory committees in each student's program. Students should discuss any problems related to their advisory committee with their faculty supervisor and, if needed, with the department head. Credit Hour Loads Full-time credit hour loads are 12 hours in Fall and Spring semesters (in addition to courses audited). Typically, students will register for 6 to 9 hours of formal course work (2 to 3 classes) during Fall and Spring terms (or less during the latter stages of a graduate program), and for sufficient hours of Research and Thesis (MS) or Research and Dissertation (PhD) credits to complete the 12-hour, full-time load. Note that this is required for payment of assistantships and for progression from assistantship step 1 to step 2, since step 2 requires the completion of 24 credit hours. Students who, prior to the beginning of a semester, will have 1) fulfilled all residency and course requirements 2) scheduled their final exam to take place within the first 20 class days of the term and 3) have thesis/dissertation ready to defend at start of semester, are eligible to request registration for 1 hour as a Defending Student (exceptions to the 20 day rule may be granted by the Graduate School). A certification form, available from the departmental office, must be submitted to the Graduate School in order to be registered as a Defending Student. Registration as a Defending Student may affect eligibility for assistantships and certain student benefits and/or loans since students so registered do not pay the comprehensive fee and are not classified as full-time students. Evaluation of Performance and Progress toward Degree In an effort to foster communications between graduate students, their faculty supervisors, and advisory committees, the Dairy Science Department requires an annual evaluation and communication of graduate student performance and progress toward either the M.S. or Ph.D. degree. The process is initiated with a written report, from each graduate student to his/her faculty supervisor, which appropriately details the graduate student's academic and research program progress during the preceding year. The form of the report is the prerogative of the faculty supervisor and due by February 1st of each year or earlier as designated by the faculty supervisor. In response, faculty supervisors will, by March 1st of each year, write a letter which details the supervisor's evaluation of each graduate student's performance and progress toward a degree. Graduate students and faculty supervisors should meet at an appropriate and convenient time to discuss the student's report and supervisor's evaluation, concentrating most especially on any differences in expectations or evaluation between the student and supervisor. Both the student's report and supervisor's letter will become a part of the student's file. It is expected that advisory committee members will be used appropriately to develop each student's academic program, in the planning and execution of the research project, and in contributing to the evaluation letter. We have recently produced a form that serves to more clearly define guidelines and requirements. Briefly, students must be registered for the minimum of three credits in the semester/summer they take an examination or when

a degree is completed. If a dissertation is ready for defense by the beginning of a semester (See http://www.grads.vt.edu/academics/dates_deadlines/commencement_deadlines.html for the deadlines for each semester of the current year) the student may qualify for Defending Student Status (DSS, 1 credit; http://www.grads.vt.edu/graduate_catalog/poli/UIPo.jsp?p=11). To assist you and your advisor, the department has created a Graduate Student Progress Check List and the Annual Graduate Student Evaluation Form. These are included at the end of this document. Time Limits for Degree Programs Guidelines for time to complete graduate degree programs are established as departmental policy in the interest of both the department and student. As a general guideline, it is expected that MS programs will be completed within two years and that Doctoral programs will require no more than three years. Students receiving financial assistance are assured of continuing support for these periods of time. In the event that circumstances prevent completion of a degree within the prescribed time limit, it is the responsibility of the student's faculty supervisor to request or provide an extension of financial support. Annual Evaluation Guidelines There are two new forms that will become part of your student record in the department. The first is a DASC Graduate Student Checklist and the second is a DASC Annual Student Evaluation Form. So you will know what is expected copies of these forms are also included as the end of this document. Copies of the forms (saved as word documents) have also been sent to your major professor and to you and are available from Becky Michael as well. The annual evaluation of graduate students provides an opportunity to insure that appropriate progress toward degree requirements is occurring and to allow for adjustments in the program of study, teaching activities, or research efforts. Clearly, it is also important to keep the advisory committees informed. Remember your advisory committee is not likely to seek you out. It is your responsibility to use your advisory committee effectively. These members can provide excellent insight, perspective, and encouragement but only if you engage them. Since the evaluations occur in the Spring Semester (see above) to meet pending graduate school requirements -- your first evaluation may well be rather brief. However, the following elements are expected to be part of your evaluation documentation as appropriate. Signatures of the Major Advisor and Committee Members (likely not applicable during your first evaluation cycle). Milestones accomplished - for example, filing of the program of study or scheduling of the preliminary exam (for a Ph.D. student). Documentation indicating that a regular meeting of the student advisory committee was held and a brief written summary of major conclusions from the meeting (may not apply with initial evaluations). List of publications. List of professional talks. Documentation of teaching activities. Listing of service activities. Awards and other honors. General academic progress - i.e. satisfactory progress in class work as well as research activities. Comments by the student Signature of Student - to indicate that her or she read and understands the document

GRADUATE COURSES (DASC)

DASC 5004:

Seminar

Reports and discussion of current research in dairy science. Required of DaSc graduate students. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

DASC 5474:

Dairy Management Decisions

Principles and techniques of evaluating dairy management alternatives, with emphasis on integration of interest, borrowed capital, income taxes, and risk in the decision process. Effective use of microcomputers, production records, and modeling techniques to evaluate management strategies. Even years. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): DASC 4474 (UG) OR DASC 4474

Corequisite(s):

DASC 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

DASC 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

DASC 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

DASC 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENTOMOLOGY

Loke Kok, Head

Professors: James Bergh; Carlyle Brewster; David Herbert; Loke Kok; Thomas Kuhar; Dini Miller; Douglas Pfeiffer; Scott Salom; Peter Schultz; Michael Weaver;

Associate Professors: Zachary Adelman; Kevin Myles; Sally Paulson; Igor Sharakhov;

Assistant Professors: Troy Anderson; Paul Marek;

General Contact: kshel@vt.edu

Student Handbook: http://web.ento.vt.edu/ento/images/graduate_handbook.pdf

The Department of Entomology provides professional expertise concerning arthropods to the commonwealth, the nation, and the world. This includes teaching, training, and advising undergraduate and graduate students; conducting basic and applied research on arthropods and disseminating the results; providing information about management of arthropods and the usefulness of beneficial arthropods available to clientele and the public; developing management strategies to control arthropod pests in Virginia; fostering development of entomological expertise at the state, national or at the The department has three major focus areas that includes: (1) Biomedical Research, with emphasis on insect genomics and urban/public health. This includes mosquito biology and vector control as they affect urban and public health, and human and animal disease; (2) Natural/Agro Ecosystems Research, with emphasis on IPM/Biological Control of pest problems, and environmental monitoring and protection, and (3) Urban Entomology and Pesticide Safety Education.

SPECIAL FACILITIES

The Entomology Department is housed in Price Hall with additional on-campus laboratory facilities located in Latham Hall and the Fralin Biotechnology building. Insectary and green house facilities are located both at on-campus and off-campus sites. Other laboratory and research facilities include: Dodson Urban Pest Management Laboratory, Quarantine Laboratory, Genetic Stock Center, Physiology, Biochemistry and Molecular Biology labs. In addition students and faculty have access to research facilities located at our Agricultural Experiment Stations located throughout the state.

Price Hall

The Entomology Department is housed in Price Hall with additional on-campus laboratory facilities located in Latham Hall and the Fralin

Biotechnology building. Insectary and green house facilities are located both at on-campus and off-campus sites. Other laboratory and research facilities include: Dodson Urban Pest Management Laboratory, Quarantine Laboratory, Genetic Stock Center, Physiology, Biochemistry and Molecular Biology labs. In addition students and faculty have access to research facilities located at our Agricultural Experiment Stations located throughout the state.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

The Entomology Department offers a Master's in Life Sciences degree with concentration in Entomology (thesis or non-thesis/online), or a Doctorate in Entomology. The graduate program offers training in basic and applied entomology through a combination of graduate courses, research programs, and teaching experience. Masters of Science in the Life Sciences Degree (MSLS)M.S. students must take at least one course in each of three core areas:(1) Biochemistry/Molecular and Cell Biology (Biochemistry for Life Sciences, Insect Physiology or Insecticide Toxicology); (2) Statistics (Biometry, Statistics in Research, or approved substitute); and (3) Information Management (Research and Information Systems in the Life Sciences). For the thesis-based M.S., 20 credit hours of course work and 10 credit hours of research are required. For a non-thesis M.S., a minimum of 30 credit hours of course work must be completed for graduation. With successful completion of both course work and research (thesis) requirements, M.S. students will receive an MSLFS in Life Sciences with a Concentration in Entomology. Students in the Non-Thesis MSLFS Program are required to complete an internship and a project in addition to course work. The Non-Thesis M.S. student will complete the course requirements outlined in the Graduate Policies and Procedures and Course Catalog and those described above for M.S. candidates in this department. They will have a Major Professor and Advisory Committee similar to those of other M.S. candidates. The Advisory Committee will supervise the Plan of Study, the selection and conduct of the internship and project, and will conduct a Final Oral Examination. Note that a Non-Thesis Masters Degree is intended to be a terminal degree and is not a satisfactory prerequisite for continuing on toward a Ph.D. The department also participates in the college on-line MSLS degree program Ph.D. Program Successful completion of a thesis-based M.S. in entomology or related field is required for admission to the Ph.D. program. Ph.D. students are expected to demonstrate competency in their area of specialization and are required to take a minimum of 27 hours of courses numbered 5000 or higher. Candidates for the Ph.D. must demonstrate breadth of experience in at least one topic apart from the major area of study. This enrichment experience must be approved by the Advisory Committee and may take the form of foreign language, business, computer science or other pre-approved topic or concentration of courses in a selective area.

MSLFS Degree

TOEFL

Paper: (550.0)*Computer:* (213.0)*iBT:* (80.0)

The Entomology Department offers a Master's in Life Sciences degree with concentration in Entomology (thesis or non-thesis/online), or a Doctorate in Entomology. The graduate program offers training in basic and applied entomology through a combination of graduate courses, research programs, and teaching experience. Masters of Science In the Life Sciences Degree (MSLS)M.S. students must take at least one course in each of three core areas:(1) Biochemistry/Molecular and Cell Biology (Biochemistry for Life Sciences, Insect Physiology or Insecticide Toxicology); (2) Statistics (Biometry, Statistics in Research, or approved substitute); and (3) Information Management (Research and Information Systems in the Life Sciences). For the thesis-based M.S., 20 credit hours of course work and 10 credit hours of research are required. For a non-thesis M.S., a minimum of 30 credit hours of course work must be completed for graduation. With successful completion of both course work and research (thesis) requirements, M.S. students will receive an MSLS in Life Sciences with a Concentration in Entomology. Students in the Non-Thesis MSLS Program are required to complete an internship and a project in addition to course work. The Non-Thesis M.S. student will complete the course requirements outlined in the Graduate Policies and Procedures and Course Catalog and those described above for M.S. candidates in this department. They will have a Major Professor and Advisory Committee similar to those of other M.S. candidates. The Advisory Committee will supervise the Plan of Study, the selection and conduct of the internship and project, and will conduct a Final Oral Examination. Note that a Non-Thesis Masters Degree is intended to be a terminal degree and is not a satisfactory prerequisite for continuing on toward a Ph.D. The department also participates in the college on-line MSLS degree program Ph.D. Program Successful completion of a thesis-based M.S. in entomology or related field is required for admission to the Ph.D. program. Ph.D. students are expected to demonstrate competency in their area of specialization and are required to take a minimum of 27 hours of courses numbered 5000 or higher. Candidates for the Ph.D. must demonstrate breadth of experience in at least one topic apart from the major area of study. This enrichment experience must be approved by the Advisory Committee and may take the form of foreign language, business, computer science or other pre-approved topic or concentration of courses in a selective area.

GRADUATE COURSES (ENT)**ENT 5004:****Graduate Seminar**

Lectures and discussions by faculty and students on a current topic pertinent to research being conducted in the department. Critical evaluation of principles, theories, and methods will be emphasized. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

ENT 5114:**Insect Structure and Function**

A comparative study of the major structures and organ systems emphasizing modifications important in the success of insects. Designed for graduate and upper level undergraduate students in entomology and zoological biology. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ENT 3014

Corequisite(s):

ENT 5214:**Arthropod Pest Mgmt**

Principles and techniques designed to reduce pest levels below those causing injury of economic importance to agriculture and forestry. Course objectives are to provide students with background information which will enable them to formulate comprehensive approaches to pest problems and emphasize alternate methods of pest control and integrated approaches to pest problems. Appropriate for graduate students in entomology, plant protection, and related curricula. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ENT 5224:**Field & Laboratory Methods in Vector-Borne Disease Research**

An in-depth examination of techniques currently employed to study vectors of human disease, as well as the pathogens they transmit. Topics include: vector sampling methods; vector competence; recombinant virus infectious clone technology and uses; isolation of pathogens from field vector populations; development and uses of transgenic vectors; GIS, remote sensing, and landscape analysis in vector surveillance; as well as arbovirus containment issues related to biosafety level 2 and 3 situations. Graduate standing required.

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ENT 3254

Corequisite(s):

ENT 5234:

Managing Arthropod Pests

Principles and techniques for reducing pests in agriculture and forestry. Concepts of pest management to enable students to formulate comprehensive approaches to solving pest problems. Integrated pest management of primarily North American crops. Pre: Two semesters of biology or two years experience in agriculture production, industry or policy. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENT 5264:

Biological Control of Arthropod Pests and Weeds

Principles involved in the use of indigenous and introduced biological agents in the regulation of arthropod pests and weeds. Course objectives are to emphasize concepts important in biological control: population dynamics, host-parasite interactions, characteristics of parasitism and predation, principles involved in current biological approaches to pest control, and use of biological agents to control weeds. Suitable for students in entomology, plant protection, and related curricula. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ENT 5324:

Genomics of Disease Vectors

An in-depth examination of the modern approaches and techniques currently employed to study genomes of arthropod vectors of human, animal, and plant diseases. Topics include: genome organization, regulation, and evolution; preparation and analysis of chromosomes; genome mapping, sequencing and assembly; principles of taxonomy and systematics; adaptation and evolution of arthropod vectors; genetics of vector competence; comparative genomics and bioinformatics. Graduate standing required.

Credit Hour(s): 0 OR 2

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ENT 5624 (PPWS 5624):

Animal and Plant Biosafety and Biosecurity

Principles, tools, and techniques of disease detection, early warning, and containment of animal and plant pathogens. Regulatory agencies and guidelines used to ensure the biosafety and biosecurity of the US food supply from accidental introductions and potential bioterrorism.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): ENT 5044

Corequisite(s):

ENT 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

ENT 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

ENT 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 0 TO 10

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ENT 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

ENT 6004:

Advanced Topics in Entomology

In depth presentations and discussions on selected advanced topics in entomology. (Maximum 4 C per course). I,II,III

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

ENT 6154:

Insect Physiology

Detailed study of the physiology and biochemistry of insect organ systems. Topics include: circulation, digestion, respiration, excretion, hormonal regulation, pheromones, intermediary metabolism, and nerve and muscle physiology. Laboratories provide exposure to instrumentation and techniques used in physiological research. II

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ENT 5114, CHEM 2535, CHEM 2536

Corequisite(s):

ENT 6164:

Insecticide Toxicology

This course is designed to teach advanced graduate students the chemistry, toxicity, mode of action, and pharmacology of insecticides and related compounds, and to give them an opportunity to learn the methods employed in studying these compounds. The course is designed for entomology and other life science majors. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ENT 6154

Corequisite(s):

ENT 6354:

Insect Behavior and Ecology

Concepts, theory, and research techniques in insect behavior and ecology. General ecology including population, spatial, and community ecology; foraging behavior; communication systems; reproductive behavior and ecology; population regulation by natural enemies; social behavior; and population management using concepts of applied ecology.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): ENT 5114

Corequisite(s):

ENT 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 0 TO 10

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

ENT 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FOOD SCIENCE AND TECHNOLOGY

Joseph Marcy, Head

Emeriti Faculty: George Flick, Jr.; Merle Pierson; Bruce Zoecklein;

Professors: Susan Duncan; Michael Jahncke; Joseph Marcy; Sean O'Keefe; Susan Sumner;

Associate Professors: Renee Boyer; Joseph Eifert; William Eigel; Monica Ponder; Robert Williams;

Assistant Professors: David Kuhn; Andrew Neilson; Amanda Stewart;

Affiliated Faculty: Melissa Chase;

Food science and technology is a fusion of chemistry, microbiology and engineering. Our researchers explore innovation in the areas of creating new, healthful food products, and ensuring a safe and tasty food supply. Specific research emphases include: improving food nutrition, quality and flavor, developing novel functional food ingredients and products for promoting human health, packaging design and use of advanced technologies to identify and control food-borne disease causing organisms. Individual graduate programs are customized with the advisor to emphasize food safety/microbiology, biochemistry, food chemistry, or packaging. Student graduate programs are built around courses in microbiology, chemistry, biochemistry, biology, engineering, and statistics. This diverse curriculum prepares students for opportunities in industry, universities or government. Students who earn graduate degrees in Food Science and Technology at Virginia Tech have pursued careers with large food companies (Nestle, Campbell, Kroger, ConAgra, Hershey, etc.) and public health agencies (USDA, FDA, State Health and Agriculture Departments). In fact, the highest food safety position in the US government has been held by a Virginia Tech Food Science and Technology graduate!

SPECIAL FACILITIES

Food Science and Technology Building

The Department of Food Science and Technology is housed in a separate 34,000 square-foot building, and is well-equipped with a variety of analytical instrumentation, equipment, and research-scale pilot plant facilities including: Food Analysis Laboratories, Microbiology Laboratories, Packaging and Processing Pilot Plant, Research Winery and Enology Laboratory, Sensory Evaluation Laboratory, Dairy/Beverage Processing Pilot Plant and Analytical Support Laboratory, and High Hydrostatic Pressure Processing Laboratory.

Human and Agricultural Biosciences Building Phase 1 (HABB1):

In 2014, the Department will move into the new Human and Agricultural Biosciences Building 1 which will house research facilities for the Biological Systems Engineering and Food Science and Technology departments. The 93,860-square-foot building will incorporate laboratory and support facilities, focusing on a wide range of microbiological and biochemical research. Researchers will benefit from the expanded space, which will house research programs on food safety, food packaging and processing, environmental quality analysis, bioenergy and biomaterials, systems biology, and nanotechnology, among other areas. Researchers and graduate students will benefit from open-plan laboratories, pilot plant research space, a sensory/flavor testing suite with individual panelist booths, prep kitchens, and group debriefing and discussion rooms. Other perks will include new offices for researchers and work spaces for graduate students.

DEGREES OFFERED

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (153.0), Quantitative (148.0)

A Masters degree is expected for students applying to the doctoral program. In exceptional cases, some students with only a Bachelors degree may be considered for a doctoral program. Students who do not have academic training equivalent to that required for a B.S. degree in Food Science and Technology at Virginia Tech will complete selected core courses before graduation. Students without a background in a science related field may be required to complete supplemental courses before being admitted to a regular student status. Any supplemental course work recommended by the Graduate Committee will be communicated to the applicant in a letter.

MS Degree

Offered In (Virtual)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

Students who do not have academic training equivalent to that required for a B.S. degree in Food Science and Technology at Virginia Tech will complete selected core courses before graduation. Students without a background in a science related field may be required to complete supplemental courses before being admitted to a regular student status. Any supplemental course work recommended by the Graduate Committee will be communicated to the applicant in a letter.

Degree Concentrations:

Food Safety

The Master of Agricultural and Life Sciences degree, with a concentration in Food Safety, is a non-thesis degree.

MSLFS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

General: Verbal (153.0), Quantitative (148.0)

Students who do not have academic training equivalent to that required for a B.S. degree in Food Science and Technology at Virginia Tech will complete selected core courses before graduation. Students without a background in a science related field may be required to complete supplemental courses before being admitted to a regular student status.

Any supplemental course work recommended by the Graduate Committee will be communicated to the applicant in a letter.

GRADUATE COURSES (FST)

FST 5004:

Graduate Seminar

Special topics, critical reviews, and discussions of current literature throughout a wide range of subject areas in food science and technology. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FST 5014:

Sensory Evaluation of Food

Principles of sensory evaluation including experimental methods, applications, and statistical analyses. I

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): STAT 2004 OR FST 4524)

Corequisite(s):

FST 5024:

Food Regulatory Affairs

History, development and enforcement of laws and regulations that affect the food processing industry and food consumers. Impact of legal and regulatory issues on food quality, safety, formulation, labeling, marketing, grading, product and process development, international trade, and processor employees. Roles and responsibilities of consumers and industry in the development of and compliance with food laws and regulations. Two of the four prerequisites listed are required.

Odd years.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FST 4405, FST 4504, FST 4524, FST 4604

Corequisite(s):

FST 5034:

Good Agricultural and Manufacturing Practices

Principles of food safety management for food producing and food processing environments. Emphasis on guidelines developed in Good Agricultural Practices for plant-based foods and Current Good Manufacturing Practices. Pre: Academic and/or professional background in food processing, quality assurance, fresh produce production, food product regulation, and/or food safety. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FST 5044:

Global Food Laws and Regulations

History of laws and regulations that affect the food processing industry and food consumers. Impact of legal and regulatory issues on food quality, safety, formulation, labeling, marketing, grading, product and process development, and international trade for the U.S. and other nations. Pre: Academic and/or professional background in food processing, quality assurance, and/or food safety.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FST 5084:

Macromolecular Interfaces with Life Sciences Seminar

Experience in developing and presenting a technical seminar related to oxidative processes at the macromolecule- biomolecule interface. Tours and presentations at research facilities at regional industrial sites. Idea generation for the purpose of resolving technical questions and advancing research projects. Pre: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell and molecular biology (Biol 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Grant Writing and Ethics

A framework for writing clear, concise grant proposals in a team-oriented, multidisciplinary approach from concept development through submission to a funding agency. Potential ethical dilemmas that may arise in academic, industrial, or federal research settings will be discussed. PRE: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell & molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. (3H, 3C).

Graduate standing required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FST 5114:

Introduction to Risk Management for Health Products

Overview of historical development in perspectives of risks and a survey of risk management models used by federal agencies such as the Food and Drug Administration and U. S. Department of Agriculture. Introduces commonly used terminology and its applications in a wide variety of risk management scenarios. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FST 5124:

Risk Management as a Business Strategy for Health Product Industries

Introduces an enterprise risk management framework as a business strategy to stimulate innovation in uncertain environments, to minimize product liability issues, and formulate strategies to address insurance coverage. Establishes a comprehensive product liability program and institutes safeguards to avoid future legal actions and losses. Incorporates theories of risk management and human behavior, related to product stewardship, in product design. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FST 5134:

Risk Science in Pharmaceutical Processes - Tools and Techniques

Management of health care pharmaceutical product and process risks. Risk management model using International Committee on Harmonization guidelines for clinical trials, pharmacovigilance, and quality risk management. Principles of Functional Analysis, Fault Tree Analysis, Failure Mode and Effects Criticality Analysis, Hazard Analysis and Critical Control Points, Hazard and Operability Study. Application of these tools on currently marketed pharmaceutical products and processes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): FST 5114, FST 5124

Corequisite(s):

FST 5144:

Risk Science in Medical Device Processes - Tools and Techniques

Overview of the historical development of the total life cycle risk management framework for risk management of medical devices. Detailed analysis of International Organization for Standardization (ISO) 14971 as the world-wide risk management framework for managing medical device products and processes. Integration of related regulatory requirements and other standards requirements affecting medical devices. Associated tools including functional analysis, fault tree analysis, failure mode and effects analysis, hazard analysis and critical control points, hazard and operability study.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): FST 5114, FST 5124

Corequisite(s):

FST 5154:

Risk Mgmt New Health Prod

Risk management models for managing challenges related to new and emerging developments in health product devices and pharmaceutical products such as biotechnology, nanotechnology, and wireless technology. Compliance/ regulatory issues and product development/manufacturing risks applied to emerging technologies. Application of risk management tools, techniques, and approaches to address recent, innovative products or hypothetical products. Emphasizes development of novel approaches to new technologically advanced health products.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): FST 5134 OR FST 5144

Corequisite(s):

FST 5164:

Health Product Risk Communication & Incident Handling

Survey of different international regulations and incident reporting systems including those of North America, Europe and Asia. Case studies of solutions to post-market problems as related to risk management. Discussion of a "culture" of risk communication for a hypothetical company. How to provide risk-based solutions to senior management.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): FST 5134 OR FST 5144

Corequisite(s):

FST 5174:

Total Life Cycle Risk Management for Health Products

Application of risk management principles integrated with systems engineering concepts to product, process and support life cycles and the iterative feedback loops of information for continuous improvement to reduce risk. Design and analysis of creating a risk management system for health product manufacturers. Initiation of an integrated risk management system into the corporate environment and application of appropriate information technologies to integrate various system elements to provide an enterprise solution. Managing health product risks at product conception and thereafter.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): FST 5134, FST 5144

Corequisite(s):

FST 5184:

Economic Analysis of Health Product Risk

Examines application of economic analytical tools based on risk management principles to healthcare products and the effect on corporate profitability. Surveys approaches suitable for economic analysis of healthcare product risk as applied throughout product life-cycle. Analyze profit vs. cost, risk vs. benefit, loss to the company, and loss to society as a result of adverse outcomes of healthcare product

risks. Examines how risk management generates short and long term financial benefits for healthcare product manufacturers. Creates applicable models to analyze current issues based on available public information.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): FST 5174

Corequisite(s):

FST 5384:

Oxidation at the Interface of Chemistry and Biology

An advanced survey of the chemistry and biochemistry associated with oxidation reactions and the relationship to positive and detrimental outcomes in synthetic and natural macromolecules and biological systems. Topics include free radical chemistry, reactive oxygen and nitrogen species in living systems, enzyme-catalyzed oxidations, oxidation of foods and materials, oxidative stress and health effects, chemistry of antioxidants. Pre: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell & molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FST 5404:

Food Packaging

Examines the role of food packaging in the preservation of foods in today's society. Food packaging materials will be discussed with emphasis on their interaction with food products. Specific applications of packaging materials to food groups will be discussed. Procedures to develop a new food package are incorporated in class activities. food industry. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FST 4405

Corequisite(s):

FST 5604:

Advances in Food Microbiology

520 Critical review of current topics in food microbiology. Foodborne

pathogens, toxins, analytical methodology, food spoilage, inhibition and destruction of bacteria, standards, and fermentations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FST 4604, BCHM 5124

Corequisite(s):

FST 5614:

Food Safety and Security

Identification and prevention of food safety and security hazards that may result in intentional or unintentional contamination. Development and implementation of plans to enhance food safety and security in the processing, distribution, transportation, and retail segments of the food supply chain. Pre: Academic and/or professional background in food processing, quality assurance, and/or food safety. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FST 5624:

Applied Food Microbiology and Sanitation

Overview of the causes, transmission, and epidemiology of major environmental, food-, and water-borne diseases in the food industry. Detection, monitoring, and control of important environmental pathogens. Chemical, physical, and biological sanitation to control pathogens in food, water, and the environment. Pre: Academic and/or professional background in microbiology, food safety, or environmental health. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

FST 5634G:

Adv Epi Food & Water Diseases

Overview of causes, transmission, and epidemiology of major environmental, food, and waterborne diseases. Outbreak and sporadic detection, source tracking, and control of pathogens. Overview of the impact of food-borne outbreaks on regulatory activities at the national

and international level. Pre-requisite: Graduate Standing required

Credit Hour(s): 4

Lecture Hour(s): 4

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FST 5664:

Flavor Chemistry

Study of flavor compounds, their isolation, extraction, and flavor profiles. Examination of compounds that are used to produce commercial flavors from synthetic and natural sources. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): FST 4504, FST 4514

Corequisite(s):

FST 5884:

Macromolecular Chemistry at the Biology Interface Laboratory

An advanced laboratory course that involves state-of-the-art experimental techniques with applications for data interpretation and presentation for future professionals at the polymer chemistry-biology interface. Team-oriented experiments will use traditional and emerging polymer chemistry techniques and applied biological methods, specifically those involving analysis of free radical and oxidative processes. PRE: CHEM/FST/BMVS 5384 or simultaneous enrollment in this course.

Credit Hour(s): 0 OR 2

Lecture Hour(s): 0 OR 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

FST 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study, VI

Instruction Type(s): Independent Study, VI

Prerequisite(s):

Corequisite(s):

FST 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

FST 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FST 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HORTICULTURE

James Harris, Head

Professors: Eric Beers; James Harris; Joyce Latimer; Richard Veilleux; Gregory Welbaum; Anthony Wolf;

Associate Professors: Robert McDuffie; Alexander Niemiera; Holly Scoggins;

Assistant Professors: Susan Day; Joshua Freeman; James Owen; Gregory Peck; James Tokuhisa; Mark Williams; Bingyu Zhao;

Adjunct Professors: Yinghui Dan; Barry Flinn; Zongrang Liu; Chuansheng Mei;

Affiliated Faculty: David Close; Laurie Fox; Sarah Gugercin; Stephanie

Huckestein; Chengsong Zhao; Mingzhe Zhao; Changhe Zhou;

Julian H. and Margaret S. Gary Professor: Richard Veilleux;

Graduate Contact: rharris@vt.edu

Graduate Site: <http://www.hort.vt.edu>

The Virginia Tech Department of Horticulture offers programs leading to the Master's and Doctoral degrees. Areas of specialization include: plant breeding and genetics growth and development physiology molecular biology intensification of production through modern cultural practices and innovative approaches urban horticulture rhizosphere biology The faculty are stationed both on campus in Blacksburg and at several experiment stations throughout the state. Although not all faculty serve directly as advisors to graduate students, all are available as resources to graduate programs.

SPECIAL FACILITIES

On Campus Modern research facilities and several offices are housed in Latham Hall. Offices, a 25-station computer lab, and several classrooms are housed in Saunders Hall. Greenhouse space assigned to the department in the campus greenhouse complex exceeds 20,000 sq. ft. Field research is mostly conducted at the 10-acre Urban Horticulture Center near campus, and the nearby 1,700 acre Kentland Farm contains orchards and vegetable and small fruit plots to support the educational and research efforts of the department. The Hahn Horticulture Gardens and Pavilion is an extensively managed six-acre site on campus that supports some of our teaching and outreach efforts Off Campus Faculty are also located at three agriculture research and extension centers (AREC) across the state. The Alson H. Smith Jr. AREC is located at Winchester and focuses its programs on tree fruits and grapes. The Hampton Roads AREC in Virginia Beach focuses on green industry (nursery and landscape) research and outreach. The Eastern Shore AREC where Horticulture faculty are located in Painter, on the Eastern shore of Virginia, focuses on vegetable research.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal (550.0), Quantitative (600.0)

Minimum Course Requirements for MS (graded classroom hours). All classes must be taken A-F if offered as such. 9 - BION, HORT, CSES, PPWS, BIOL (4000-6000 level; 6 hours max of 4000)*3 - Advanced statistics (STAT)1 - Research Ethics in Agriculture and Life Sciences (ALS 5324)1 - Professional Communication in Ag. and Life Sciences (ALS 5334)1 - Horticulture Seminar (HORT 5004)MINIMUM CLASSROOM REQUIREMENT = 20**6 -10 - Research and Dissertation (HORT 5994)TOTAL CREDIT HOURS REQUIRED = 30*Independent study not applicable; 6 hours max for 4000 level**At least 5 additional hours to be approved by advisory committee = 20 hours minimumAn oral

defense of a thesis is also required

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General: Verbal (550.0), Quantitative (600.0)

Minimum Course Requirements for PhD (includes courses accepted by advisory committee from MS); advisory committee may require additional 12 - BION, HORT, CSES, PPWS, BIOL (5000-6000 level only)6 - Advanced statistics (STAT)1 - Research Ethics in Agriculture and Life Sciences (ALS 5324)1 - Professional Communication in Ag. and Life Sciences (ALS 5334)2 - Horticulture Seminar (HORT 5004)MINIMUM CLASSROOM REQUIREMENT = 22*30-70 Research and Dissertation (HORT 5994)TOTAL CREDIT HOURS REQUIRED = 90*Independent study not applicable; 5000-6000 classes only.An oral and written preliminary exam and a successful defense of a dissertation are also required.

GRADUATE COURSES (HORT)

HORT 5004:

Seminar

Formal presentation and discussion of current problems, programs, and research studies in horticulture. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5104:

Introduction to Graduate Studies and Research

Introduction to topics and processes important during and following graduate study in a Land Grant institution. Topics include philosophy of the Land Grant institution, the scientific process, experiment station project proposals, literature reviews and library information retrieval systems, function of statistics in research, manuscript preparation, oral and poster paper presentation, peer review of manuscripts, grant proposals, and thesis and dissertation preparation. I

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5204:

Horticultural Communication in Writing

The business of writing and marketing horticultural publications including magazine, newspaper, and web articles, extension publications, newsletters, manuals, and books. Marketing writing and understanding legal issues. Visual enhancement with illustrations and photographs.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5304 (CSES 5304):

Advanced Plant Genetics and Breeding

Plant breeding theory and methodology for the improvement of agronomic and horticultural crops; genetic diversity; polyploidy; gene inheritance, expression, interaction, and stability; incompatibility; male sterility; haploidy; genetic engineering and transformation; parental selection, hybridization, and population development; breeding methods, genotypic and phenotypic selection and evaluation; strategies for cultivar development including marker assisted selection and breeding for durable disease resistance. Graduate standing required.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): BIOL 2004 (UG) OR BIOL 2004 OR CSES 4144 (UG) OR CSES 4144

Corequisite(s):

HORT 5404:

Plant Tissue Culture

The use of aseptic techniques for the culture and manipulation of plant cells, tissues, and organs with emphasis on developmental, physiological, and genetic applications. II

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): , PPWS 3514

Corequisite(s):

HORT 5474 (FOR 5474):**Adv Stud in Urban For Ecosys**

The nature and dynamics of urban ecosystems with emphasis on the role of urban forests. Examines the interactions of urban forests with the built environment at multiple scales and from multiple disciplinary perspectives. Management influence on ecosystem processes and approaches to estimating urban forest ecosystem services from urban cores to pre-urban development. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HORT 5504:**Nutrition of Horticultural Crops**

Principles of mineral nutrition for the production and utilization of fruits, vegetables, and ornamentals; functions of mineral nutrients, correction of deficiencies and imbalances associated with physiological disorders of usable plant parts; and interactions of mineral nutrients with environmental and cultural factors. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): , PPWS 3514, CSES 3114

Corequisite(s):

HORT 5514:**Plant Nutrition**

Fundamentals of plant nutrient availability, uptake, assimilation, transport, function, and deficiencies. Influence of plant root environment and root physiology on plant nutrient status and subsequent effect on plant growth, crop yield, and relationship to plant diseases and pests.

Pre: Graduate Standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HORT 5524 (PPWS 5524):**Advanced Plant Physiology and Metabolism I**

Plant metabolism and its regulation, cell and organ structure and

function. Current understanding of photosynthesis, respiration, nitrogen fixation, mineral nutrition, water and ion transport in plant cells and tissues, ecophysiology and responses of plants to the environment. Pre: undergraduate major in Biology or related discipline. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5534 (PPWS 5534):**Advanced Plant Physiology and Metabolism II**

Presentation of the current understanding of metabolic and functional relationships among primary and secondary metabolites and storage products and their impact on the whole plant. Biosynthesis of phytohormones. Mechanisms controlling responses to phytohormones including: impact on carbon/nitrogen partitioning, senescence, development of higher plant structures such as vascular tissue and flowers. PRE: undergraduate major in Biology or related discipline. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HORT 5604:**Physiol Crop Plants**

Growth and phasic development of crop plants. Emphasis on cellular and metabolic aspects of germination, organ formation, flowering, fruiting, senescence, and the role of environment and bioactive substances. Consent required. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5644G:**Adv Small Fruit Production**

Propagation, production, and marketing of small fruit crops for the mid-Atlantic. Emphasis on sustainable practices, market sectors, and health and nutritional benefits. Blueberries, strawberries, brambles, and other crops. Pre-requisite: Graduate Standing required

524 Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5654G:

Advanced Viticulture

Overview of Virginia wine grape industry, grapevine growth and development, and factors affecting yield quality. Vineyard financial considerations, site evaluation, varietal characteristics plus cultural practices of pruning, training, canopy management, fertilization and pest management. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HORT 5764G:

Advanced Vegetable Crops

Advanced topics in vegetable production, post-harvest handling, economic importance, nutritional value, organic standards, consumption, biotechnology. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HORT 5784G:

Advanced Vegetable Seeds

Study of vegetable seed production focusing on pollination biology, molecular assessment of seed biology, and current research on seed biology. Seed production, handling, identification, conditioning, enhancement, packaging, storage, testing, federal standards, and biotechnology.

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): HORT 5764G

Corequisite(s):

HORT 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

HORT 5914:

Ecology of Plant-Microbial Interactions

Diversity, structure and function of microorganisms and how they interact with plants at the root-soil interface. Plant-microbial interactions as drivers of global biosphere and sustainability of unmanaged and managed ecosystems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HORT 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

HORT 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

525 Corequisite(s):

HORT 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HORT 6004:**Advanced Topics in Horticulture**

In-depth presentations and discussions in a specific area of advanced horticulture. Topics will vary, and course may be taken for credit more than once. I,II,III

Credit Hour(s): 1 TO 4

Lecture Hour(s): 1 TO 4

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HORT 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HUMAN NUTRITION, FOODS, AND EXERCISE

Matthew Hulver, Head

Professors: George Davis; Kevin Davy; Paul Estabrooks; Susan Hutson; Janet Rankin; Jay Williams;

Associate Professors: Brenda Davy; Deborah Good; Robert Grange; Matthew Hulver; Young Ju; Dongmin Liu; Eva Schmelz; Elena Serrano;

Assistant Professors: Fabio Almeida; Zhiyong Cheng; Jamshid Davoodi; Madlyn Frisard; Samantha Harden; Valisa Hedrick; Jennie Hill; Vivica Kraak; Jamie Zoellner;

Graduate Contact: savillsk@vt.edu**Graduate Site:** http://www.hnfe.vt.edu/graduate_academics/index.html

Our mission is to discover, translate, and disseminate health-related advances in the nutrition, food, and exercise sciences. Contribute significantly to scientific progress through molecular and clinical advances leading to prevention and improved treatment of obesity and chronic diseases; behavioral discoveries that lead to effective intervention programs for youth and adults; and interdisciplinary research teams who speed the translation of scientific discoveries to effective therapeutic and public health interventions that will benefit Virginians and the nation. Provide exceptional training and programs for our students; prepare future professionals who are knowledgeable and committed to life-long learning; produce graduates who are ethical, culturally sensitive, and able to work collaboratively as well as independently; and use rigorous scientific inquiry to create new training programs for undergraduate and graduate students. HNFE was first established in 1960 and has approximately 900 undergraduate students, 57 graduate students, and 34 faculty members (including postdoctoral associates). HNFE offers programs leading to the M.S. and Ph.D. degrees. The Department participates in teaching, research, and community outreach. Faculty in the department generate more than \$6 million in research funding from the National Institutes of Health, the U.S. Department of Agriculture, American Heart Association, Muscular Dystrophy Association, National Cancer Institute, American Diabetes Association and the U.S. Department of Defense, as well as a variety of private agencies. HNFE faculty members hold appointments within Virginia Cooperative Extension, providing an opportunity for graduate students to participate in community-based nutrition programs. HNFE provides nutrition assessment and individual and group counseling services to University students, faculty, and staff. This program provides an option for graduate students who wish to develop skills and obtain supervised experience in nutrition counseling and community nutrition education activities. The HNFE faculty enjoys strong collegial relationships with others of similar interests in the Departments of Biochemistry, Animal Science, Food Science and Technology, other departments within the College of Agriculture and Life Sciences, with the College of Veterinary Medicine as well as the Departments of Psychology and Human Development. There are strong ties with the Student Health Center, statewide and national food and nutrition programs, and community agencies and health care facilities in the Blacksburg, Roanoke, and surrounding areas. The department faculty members are committed to the individual mentoring of each student. A faculty member usually has no more than four to six graduate students, allowing time for careful attention to each. Students also learn to know faculty and other graduate students who serve as informal mentors through graduate classes and attendance at Department seminars or informal research presentations.

SPECIAL FACILITIES

Laboratory facilities available to support graduate student research include: two molecular nutrition laboratories, two muscle function laboratories, a comprehensive body composition laboratory, and two foods laboratories including a sensory evaluation facility. Small animal care facilities are located in Integrated Life Sciences Building I (Building 23) at the CRC to HNFE for student and faculty projects. War Memorial Hall houses the human integrative physiology laboratory and the clinical exercise-testing laboratory. HNFE's partnership with Carilion Clinic has resulted in the Translational Obesity Research Program at Virginia Tech Riverside in Roanoke, which strives to produce a public health impact through physical activity, nutrition, and weight management interventions. The Department also places considerable effort on generating and disseminating research findings. Research laboratories found in Wallace Hall, War Memorial Hall, and the Corporate Research Center are equipped with state-of-the-art equipment designed for studies

ranging from molecular biology to human exercise performance. In addition, exercise activity areas; a heated swimming pool and weight training facilities are available.

Facilities

The Department of Human Nutrition, Foods and Exercise occupies space in Wallace Hall, War Memorial Hall, the Integrated Life Sciences Building at the Corporate Research Center, and VT Riverside in Roanoke. In Wallace Hall you can find the Laboratory for Eating Behaviors and Weight Management and the Metabolic Kitchen. The Integrated Life Sciences Building houses researchers from diverse backgrounds including, but not limited to, virology, biology, nutritional biochemistry, genetics, foods science, and behavioral science. A more recent development was development of the Fralin Translational Obesity Research Center which is comprised of researchers focused on translational research across the spectrum of basic, clinical, and behavioral sciences. The Molecular Nutrition, Muscle Function, and Muscle Metabolism laboratories can be found here as well as groups working on the molecular aspects of health, nutrition and disease, including genetic determinants of obesity and the prevention of cancer, diabetes, and hypertension. This research is performed in laboratories equipped with modern molecular and cell biology instruments and tools for cellular and animal research. The new vivarium also houses the equipment for the metabolic phenotyping core that allows for determination of body composition, whole body energy metabolism, glucose and insulin tolerance, analysis of metabolites, and more. Furthermore, core facilities for quantitative real-time PCR, cell culture, radio-labeled substrate metabolism, mitochondrial function, histology, confocal microscopy, and flow cytometry are localized in the building that are available for researchers and students. The clinical and behavioral scientists and the Fralin Translational Obesity Research Center have additional space at VT Riverside for their clinical and community studies. The Human Integrative Physiology laboratory is located in War Memorial Hall and provides the infrastructure for clinical studies requiring measurements of cardiovascular structure and function, submaximal and maximal exercise performance, body composition (DEXA), resting and exercise energy expenditure and substrate metabolism, and collection and processing of tissue and blood samples. Medical oversight is provided by a cardiologist from Carilion Clinic and a research nurse assists with the performance of individual studies.

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (600.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (400.0), Quantitative (500.0), Analytical (500.0)

For acceptance, an individual must have received a bachelor's degree from an institution comparable to Virginia Tech and must have demonstrated potential for advanced study by the scholastic record achieved in previous programs of study. Entering graduate students are expected to have successfully completed undergraduate courses in mathematics, biological sciences and chemistry. Some options also require coursework in nutrition, foods, and exercise science. Graduate students may earn a MS or a PhD with emphasis in: Molecular and Cellular Science Clinical Physiology and Metabolism Behavioral and Community Science

Degree Concentrations:

Molecular and Cellular Science Option

The Molecular and Cellular Science (MCS) Track in HNFE is designed to train students in molecular and cellular approaches to understand the role of diet, nutrients and exercise in health and disease. The goal of both the MS and PhD programs is to train highly competent, independent and critical thinkers who can pose directed and relevant scientific hypotheses, can test these hypotheses using a wide spectrum of laboratory methods; and can draw from the results, following rigorous statistical analysis, appropriate conclusions. Our graduates will be leaders of scientific enquiry in the field of human nutrition, foods and exercise, and, in addition, be practitioners of translating findings in the laboratory into public practice. Learning Objectives and Skills to be Acquired in the Molecular and Cellular Science Track: 1. Graduates understand and can implement the principles of research design and ethics. 2. All graduates are able to identify a research question, develop a testable hypothesis, design and conduct a study to test the hypothesis, analyze and interpret results, and present the data. 3. Graduates are able to write, present, and critique scientific papers. 4. All graduates have an understanding and demonstrate proficiency in common and novel research methods and techniques related to their area of research. 5. All graduates will understand the metabolic pathways, the molecular interactions of diet and gene regulation, and have a fundamental understanding of important signaling events regulated by nutrients and other bioactive compounds in the diet. 6. Graduates understand the basic principles of exercise physiology and are able to relate these to diet and metabolic disease. 7. Graduates understand how foods and nutrients are involved in maintaining health and prevent disease. Prerequisites: For acceptance MCS Track, an individual must have received, from an institution comparable to Virginia Tech, a Bachelor's degree to enter our MS or PhD programs or a Master's degree to enter our PhD program. The applicant must have demonstrated the potential for advanced study by the scholastic record achieved in previous programs of study.

Entering graduate students are expected to have successfully completed

undergraduate courses in health sciences. Overall grade point average should be 3.0 or higher on a 4.0 scale. It is expected that students admitted to the MCS Track will have completed coursework in the following courses: • Required: o General Chemistry o Organic Chemistry o Biochemistry o Anatomy and Physiology • Preferred: o Exercise Physiology o Kinesiology o Metabolism o Statistics Students who do not have these prerequisites in their entirety or have a lower grade point average may be admitted on a conditional or provisional basis.

Conditional or provisional status means that the student has one semester to bring their GPA up to a 3.0. International students are not eligible to be admitted as a conditional or provisional student. Additional course work may be added to the students' plan of study to address shortfalls if deemed necessary by the student's program chair and committee. Students considering the MCS track are not discouraged to apply if they do not meet all of the requirements for admission. In some cases, work or research experience may satisfy missing prerequisites.

Clinical Physiology and Metabolism Option

The goal of the Clinical Physiology and Metabolism Track (CPM) is to develop graduate students who will be able to identify, understand, and apply basic concepts of the scientific method (observation, prediction, and experiments/intervention) as it pertains to clinical and experimental research in human nutrition, foods and/or exercise science. Learning Objectives and Skills to be Acquired in the Clinical Physiology and Metabolism (CPM) Track Our objectives below contribute to the core competencies required of graduate students in the Department of Human Nutrition, Foods, and Exercise. 1. Graduates will demonstrate the ability to design and implement physiological and/or metabolic experiments and acquire knowledge and skill in utilizing state of the art methodologies to study problems relevant to human nutrition, foods and exercise. 2. Graduates will demonstrate an understanding of the pathogenesis of chronic diseases related to physical inactivity and poor dietary habits. 3. Graduates will acquire a fundamental understanding of United States Departments of Agriculture (USDA) and Health and Human Services (DHHS) Dietary Guidelines for Americans and the DHHS physical activity guidelines, including the evidence that underlies those recommendations. 4. Graduates will acquire advanced knowledge in physiology and metabolism, specifically related to the areas of human nutrition, foods and exercise science. Pre-requisites of this Track: For acceptance into the graduate program in the CPM track an individual must have received a Bachelor's degree from an institution comparable to Virginia Tech and must have demonstrated potential for advanced study by the scholastic record achieved in previous programs of study. Entering graduate students are expected to have successfully completed undergraduate courses in health sciences. Overall grade point average should be 3.0 or higher on a 4.0 scale. It is expected that students admitted to the CPM track will have completed coursework in a minimum of 4 of the following general areas: 1. Physical activity, exercise

physiology, or kinesiology 2. Nutrition, metabolism, or biochemistry 3. Psychology, sociology, or anthropology 4. Statistics, Epidemiology, or equivalent Students who do not have these prerequisites in their entirety or have a lower grade point average may be admitted on a conditional or provisional basis. Conditional or provisional status means that the student has one semester to bring their GPA up to a 3.0. International students are not eligible to be admitted as a conditional or provisional student. Additional course work may be added to the students' plan of study to address shortfalls if deemed necessary by the student's program chair and committee. Students considering the CPM track are not discouraged to apply if they do not meet all of the requirements for admission. In some cases, work or research experience may satisfy missing prerequisites.

Behavioral and Community Option

The goal of the Behavioral and Community Track (BC) is to develop graduate students who will be able to identify, understand, and apply basic concepts of the scientific method (observation, prediction, and experiments/intervention) as it pertains to human nutrition, food, and physical activity behaviors within the context of community and clinical settings. Learning Objectives and Skills to be Acquired in the Behavioral and Community Track Our objectives below contribute to the core competencies required of graduate students in the Department of Human Nutrition, Foods, and Exercise. 1. Graduates will be able to implement appropriate behavioral assessment strategies for physical activity, food practices and/or nutrient intake across clinical, community, and public health settings (Core Competency 1 and 2). 2. Graduates will be able to assess the impact of behavioral nutrition and physical activity policy, program, and practice approaches across a broad set of metrics that may include but are not limited to reach, effectiveness, adoption, implementation, maintenance, ecological impact, and cost (Core Competency 1-4). 3. Graduates acquire a fundamental understanding of dietary and physical activity guidelines, including the evidence that underlies those recommendations (Core Competency 3). 4. Graduates will be able to identify and describe individual, social, and physical environmental characteristics that promote or inhibit healthful eating and physical activity (Core Competency 3). 5. Graduates will be able to design interventions to promote healthful eating and physical activity at the individual, community, and/or public health levels (Core Competency 3). Students are required to complete the two-term departmental core course sequence (to be introduced Fall 2012, and Spring 2013) and fulfill the statistics requirement. All BC track students are required to complete the track-specific research methods course. All other courses are electives and a program of study will be determined by the student, program chair, and committee. The following courses are regularly offered (i.e., at least every 2 years) and recommended, but not required, for all BC track students. Core competency and track objective information covered in each course are also described below. 1.

Research Methods: Behavioral Nutrition and Physical Activity 2. Public Health Nutrition and Physical Activity 3. Community Based Participatory Research 4. Social Determinants of Health 5. Dissemination and Implementation Science in Behavioral Medicine Additional special topics courses will be available based upon student interest and graduate faculty availability. In addition, there are a range of courses offered through other departments (e.g., Agricultural Economics, Education, Psychology) that BC track students can complete as part of their plan of study. Pre-requisites of this Track: For acceptance into the graduate program in the BC track, an individual must have received a Bachelor's degree from an institution comparable to Virginia Tech and must have demonstrated potential for advanced study by the scholastic record achieved in previous programs of study. Entering graduate students are expected to have successfully completed undergraduate courses in social, biological, and health sciences. Overall grade point average should be 3.0 or higher on a 4.0 scale. It is expected that students admitted to the BC track will have completed coursework in a minimum of 4 of the following general areas: 1. Physical activity, exercise physiology, or kinesiology 2. Nutrition, metabolism, or biochemistry 3. Psychology, sociology, or anthropology 4. Statistics, Epidemiology, or equivalent. Students who do not have these prerequisites in their entirety or have a lower grade point average may be admitted on a conditional or provisional basis. Conditional or provisional status means that the student has one semester to bring their GPA up to a 3.0. International students are not eligible to be admitted as a conditional or provisional student. Additional course work may be added to the students' plan of study to address shortfalls if deemed necessary by the student's program chair and committee.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal (500.0), Quantitative (500.0), Analytical (500.0)

For acceptance, an individual must have received a bachelor's degree from an institution comparable to Virginia Tech and must have demonstrated potential for advanced study by the scholastic record achieved in previous programs of study. Entering graduate students are expected to have successfully completed undergraduate courses in mathematics, biological sciences and chemistry. Some options also require coursework in nutrition, foods, and exercise science. Specific courses requirements are listed below. PhD Degree Program There are three categories for acceptance: The normal entry is following completion of a M.S. that includes a research component (master's thesis) with a student demonstrating potential for further research and

scholarly achievement. The fast track entry from MS to PhD - before students complete all their M.S. degree requirements, but have a BS degree. The direct entry process provides a mechanism for exceptional, committed students to directly enter the Ph.D. program on completion of their B.S. NOTICE: Graduate students are not accepted until a faculty member takes them as an advisee. This guarantees that you have someone to work with when you arrive. Graduate students may earn a MS or a PhD with emphasis in: Molecular and Cellular Science Clinical Physiology and Metabolism Behavioral and Community Science

Degree Concentrations:

Molecular and Cellular Science Option

The Molecular and Cellular Science (MCS) Track in HNFE is designed to train students in molecular and cellular approaches to understand the role of diet, nutrients and exercise in health and disease. The goal of both the MS and PhD programs is to train highly competent, independent and critical thinkers who can pose directed and relevant scientific hypotheses, can test these hypotheses using a wide spectrum of laboratory methods; and can draw from the results, following rigorous statistical analysis, appropriate conclusions. Our graduates will be leaders of scientific enquiry in the field of human nutrition, foods and exercise, and, in addition, be practitioners of translating findings in the laboratory into public practice. Learning Objectives and Skills to be Acquired in the Molecular and Cellular Science Track: 1. Graduates understand and can implement the principles of research design and ethics. 2. All graduates are able to identify a research question, develop a testable hypothesis, design and conduct a study to test the hypothesis, analyze and interpret results, and present the data. 3. Graduates are able to write, present, and critique scientific papers. 4. All graduates have an understanding and demonstrate proficiency in common and novel research methods and techniques related to their area of research. 5. All graduates will understand the metabolic pathways, the molecular interactions of diet and gene regulation, and have a fundamental understanding of important signaling events regulated by nutrients and other bioactive compounds in the diet. 6. Graduates understand the basic principles of exercise physiology and are able to relate these to diet and metabolic disease. 7. Graduates understand how foods and nutrients are involved in maintaining health and prevent disease. Prerequisites: For acceptance MCS Track, an individual must have received, from an institution comparable to Virginia Tech, a Bachelor's degree to enter our MS or PhD programs or a Master's degree to enter our PhD program. The applicant must have demonstrated the potential for advanced study by the scholastic record achieved in previous programs of study. Entering graduate students are expected to have successfully completed undergraduate courses in health sciences. Overall grade point average should be 3.0 or higher on a 4.0 scale. It is expected that students admitted to the MCS Track will have completed coursework in the following courses: • Required: o General Chemistry o Organic Chemistry

Physiology Kinesiology Metabolism Statistics Students who do not have these prerequisites in their entirety or have a lower grade point average may be admitted on a conditional or provisional basis. Conditional or provisional status means that the student has one semester to bring their GPA up to a 3.0. International students are not eligible to be admitted as a conditional or provisional student. Additional course work may be added to the students' plan of study to address shortfalls if deemed necessary by the student's program chair and committee. Students considering the MCS track are not discouraged to apply if they do not meet all of the requirements for admission. In some cases, work or research experience may satisfy missing prerequisites.

GRADUATE COURSES (HNFE)

HNFE 5044:

Seminar in Human Nutrition and Foods

Critical review and oral reporting of pertinent literature and research in the various areas of foods and nutrition. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5125G:

Adv Medical Nutrition Therapy

Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. Emphasis on the relationship between principles of nutritional care and the medical treatment of individuals with selected diseases or clinical problems. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5126G:

Adv Medical Nutrition Therapy

Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. Integration of knowledge of pathophysiology, biochemical, and clinical parameters, medical treatment and nutrition therapy for patients with selected clinical problems/disease states.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HNFE 5125G

Corequisite(s):

HNFE 5144:

Molecular Aspects of Nutrition and Disease

The role of specific nutrients in human and animal health at a physiologic and molecular level. Emphasis is placed on the influence of nutrients on gene expression especially with regard to pathophysiology of diseases. Physiological and molecular aspects of nutrition and immune function will also be discussed. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5124, (ALS 5104 OR HNFE 5104)

Corequisite(s):

HNFE 5224:

Proteins and Enzymes in Foods

Physical and chemical properties and reactions of proteins and enzymes in foods. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): HNFE 3234

Corequisite(s): BCHM 5124

HNFE 5604:

Principles of Public Health Nutrition

This course provides knowledge of community assessment, planning, implementation, and evaluation as related to nutrition services in health programs. It presents a conceptual background for viewing dietary as well as social, economic, and environmental factors influencing health and nutritional status of populations. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HNFE 4624, HNFE 5654

Corequisite(s):

Maternal and Child Nutrition

Nutritional needs and problems of pregnant and lactating women, infants, and children in relation to their nutritional physiology; physiological and pathological basis for current research and public health programs in this area are discussed. I

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HNFE 2014, HNFE 4624

Corequisite(s):

HNFE 5624:

Nutrition and Aging

Concepts and principles relevant to nutrition of the aging individual are discussed. Consideration of physiological changes, major nutritional needs, and the application of nutrition principles are included. Human physiology and upper division nutrition course required. I

Credit Hour(s): 2

Lecture Hour(s): 2

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5684 (PHS 5214):

Program Development in Health Education

Theory, trends, and design of community health education programs implemented in communities, health agencies, hospitals, and industry.

Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): null null

Corequisite(s):

HNFE 5694 (PHS 5044):

Public Health Administration

This course will focus on relevant and timely public health administration concepts. The major topics covered include: health policy, health care planning, health care economics, health law, and managerial functions as they relate to health care and public health settings. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5724 (PHS 5024):

Epidemiology

Epidemiology is the study of the distribution and determinants of the varying rates of diseases, injuries, or other health states in human and animal populations. This course consists of an introduction to epidemiological terminology, concepts and research methodology. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5754:

Internship in Human Nutrition and Foods

Student participation in a planned clinical experience under supervision of a university staff member in an appropriate work center. (Maximum 12C). Consent required.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5764:

Externship in Human Nutrition and Foods

Special interdisciplinary problem-solving clinics for experienced health practitioners who are engaged part-time in graduate study while continuing in positions of leadership in health organization. (Maximum 12C). Consent required.

Credit Hour(s): 1 TO 12

Lecture Hour(s): 1 TO 12

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5834:

Metabolic Aspects of Exercise

A study of basic energy and muscle metabolism during exercise and the adaptations which develop through physical training. II

Credit Hour(s): 0 OR 3

531 Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): HNFE 3804, (HNFE 3025 OR BCHM 2024)

Corequisite(s):

HNFE 5844:

Exercise Testing and Prescription

A study of theory and practice of clinical exercise testing for determination of functional capacity in apparently healthy adults and those with selected chronic diseases, primarily ischemic heart disease.

The scientific and clinical basis of prescribing developmental and rehabilitative exercise for these two types of individuals. II

Credit Hour(s): 0 OR 3

Lecture Hour(s): 0 OR 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): HNFE 5824

Corequisite(s):

HNFE 5854:

Workshop in Preventive and Therapeutic Exercise

Theory and practice of exercise training for adult fitness and certain chronic disease clients, especially those with ischemic heart disease.

Topics include physiology of training, implementation, and monitoring of medically prescribed exercise, leadership techniques, primary and secondary prevention of ischemic heart disease, and program administration. III

Credit Hour(s): 1

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s): HNFE 5844

Corequisite(s):

HNFE 5874:

Advanced Sports Nutrition

Investigation of the role of nutrition in optimizing physical performance and health of active individuals. Emphasis will be on evaluation of the latest scientific information regarding sports nutrition and translation of this information for athletes and the general public. II.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): HNFE 3804, BION 5124

Corequisite(s):

HNFE 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

HNFE 5964:

Field Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

HNFE 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

HNFE 6064:

Advanced Topics in Human Nutrition, Foods and Exercise

Critically evaluate and discuss contemporary and/or ongoing controversial issues in human nutrition, foods and exercise. May be repeated with different content for a maximum of 12 credit hours.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

HNFE 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

HNFE 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PLANT PATHOLOGY, PHYSIOLOGY, AND WEED SCIENCE

Elizabeth Grabau, Head

Emeriti Faculty: Edward Hagood; Patrick Phipps; Erik Stromberg; Sue Tolin; Henry Wilson;

Professors: Jeffrey Derr; Jonathan Eisenback; Elizabeth Grabau; Ruth Grene; Chuanxue Hong; Charles Johnson; John McDowell; James Westwood; Keith Yoder;

Associate Professors: Shawn Askew; Antonius Baudoin; John Jelesko; Steven Rideout; David Schmale; Boris Vinatzer;

Assistant Professors: Maria Balota; Jacob Barney; Eva Colla'kova'; Hillary Mehl; Mizuho Nita; Sakiko Okumoto; Guillaume Pilot; Xiaofeng Wang;

Research Faculty: Cynthia Denbow; Perry Hipkins;

Instructors: Mary Hansen;

General Contact: cris75@vt.edu

Graduate Site: <http://www.ppws.vt.edu/>

The core mission of Department of Plant Pathology, Physiology and Weed Science (PPWS) is to optimize plant productivity and quality by limiting the impact of biotic and abiotic stresses on the profitability of crops and other plant enterprises, as well as the impact of these stresses on natural and agricultural ecosystems. The Department offers a Ph.D. degree in several areas of concentration within the department: plant pathology, the study of diseases, plant pathogens and their management; plant physiology, the study of plant function, growth and development and response to environmental stresses; weed science, the study of weed biology, ecology and management; and molecular plant sciences, basic biology, biochemistry and genetics of plant and plant pathogen systems. At the master's level, PPWS students participate in the M.S. program in Life Sciences, which also allows flexibility among the different options. Finally, the Department participates actively in several interdepartmental programs such as the Molecular Cell Biology and Biotechnology Program, Genetics, Bioinformatics, and Computational Biology program, the Molecular Plant Sciences program, and numerous international programs.

SPECIAL FACILITIES

PPWS facilities are located on-campus (Blacksburg) and at the Virginia Agricultural and Extension Centers (ARECs), including: Price Hall (main office), BlacksburgLatham Hall, BlacksburgGlade Road Complex, BlacksburgKentland Farm, BlacksburgTidewater AREC, SuffolkEastern Shore AREC, PainterSo. Piedmont AREC, BlackstoneAlson H. Smith AREC, WinchesterHampton Rds. AREC, Virginia Beach

DEGREES OFFERED

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Masters degree: PPWS offers the M.S. degree in any of the departmental concentrations. M.S. students meet the core requirements of the M.S. in Life Sciences program and choose electives for the plan of study in consultation with a three-person advisory committee. The M.S. requires 30 credit hours, including at least 6 research credits for the thesis option; a non-thesis option is also available. M.S. students are required to present a research seminar and a final defense seminar and participate in one teaching activity. All M.S. students meet annually with the advisory committee for an annual progress evaluation.

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

Doctoral degree: PPWS offers the Ph.D. degree in any of the departmental concentrations. The Ph.D. degree requires 21 credit hours of coursework and a total of 90 credit hours for graduation. Ph.D. students develop a plan of study in consultation with a four- or five-person advisory committee in the third semester and take both written and oral preliminary examination in the fourth semester of graduate studies. Ph.D. students present two departmental seminars, a final defense seminar and participate in two graduate teaching activities. All Ph.D. students meet annually with the advisory committee for an annual progress evaluation.

GRADUATE COURSES (PPWS)

PPWS 5004:

Seminar

Review, discussion, invention, analysis, and synthesis of principles and concepts in plant pathology, plant physiology, and weed science. May be repeated. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5034:

Clinic and Field Experience

Student interns will participate in either a plant disease or a weed oriented clinic experience. Student interns will learn to diagnose and make recommendations for control of plant diseases from specimens received by the Plant Disease Clinic, or will learn to identify and make recommendations for control of weeds received by the Weed Clinic.

Each of the two options within the course may be taken once for credit. I

Credit Hour(s): 1

Lecture Hour(s):

Instruction Type(s): Lab

Instruction Type(s): Lab

Prerequisite(s): , PPWS 4754

Corequisite(s):

PPWS 5044 (APSC 5044):

Biotechnology in Agriculture and Society

Worldwide impact of biotechnology applied to plants, animals, and microorganisms. Concepts, scientific and ethical issues, and public concerns related to genetic engineering. Safety and release of genetically engineered organisms; bioremediation; cloning, transgenic plants, animals, and microbes. Graduate Standing required. Two semesters each of biology and chemistry.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5054:

Plant Pathogenic Agents

Biology of plant pathogenic fungi, prokaryotes, viruses, and nematodes: morphology, taxonomy, ecology, plant-pathogen interactions, symptomatology, and selected aspects of management. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

PPWS 5064 (BIOL 5064) (ALS 5064) (BCHM 5064):

Seminar in Molecular Cell Biology and Biotechnology

Review and discussion of current problems and literature in molecular cell biology and biotechnology by students, VPI&SU faculty and outside speakers. Students give formal presentations of research results or current literature. May be taken on pass-fail basis. Students enrolled in the MCBB Ph.D. option will be required to give one formal presentation on an A-F basis. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5204:

Principles of Plant Disease Management

Methods of plant disease management, and theories and effectiveness of their application. Discussion based on epidemiological principles.

Methods include: cultural practices, resistance, chemical, and biological control. Laboratory 5214 supplements this course. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PPWS 3104

Corequisite(s):

PPWS 5214:

Diseases of Crop Plants

Symptoms, pathogen morphology, etiology, epidemiology, and practical control principles for important diseases of grains, oilseeds, legumes, forages, vegetables, fruits, ornamentals, and turf. Two semesters of college biology and one course in general plant pathology or equivalent exposure required. Graduate standing required.

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PPWS 3104

Corequisite(s): null null

PPWS 5304:

Plant Stress Physiology

Analysis of physiological responses of agricultural and native plants to environmental stresses such as extremes of temperature, availability of water and nutrients, and presence of air pollutants. Emphasis on linking stress caused changes in carbon gain, water loss, nutrient utilization, and energy balance with changes in growth. Laboratory to introduce equipment and research approaches used in greenhouse and field studies. II

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5314 (GBCB 5314):

Biological Paradigms for Bioinformatics

This course is an intensive introduction to the central paradigms of molecular cell biology for bioinformatics. Material from cell molecular biology, and genetics will be presented, and placed in a genomics context. The course prepares students in mathematical disciplines to interact in teams in the pursuit of bioinformatics research. Pre: Senior or graduate standing in mathematically-based disciplines such as computer science, statistics, mathematics or engineering.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5334:

Plant Water Relations

Properties and status of water in the plant and thermodynamics in relation to water and solute movement; measuring water deficits and drought tolerance; and transpiration and stomatal action. I

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5344 (BCHM 5344):

Molecular Biology for the Life Sciences

A multi-disciplinary treatment of gene organization and expression in animal and plant systems. Emphasis on the applications of molecular biology to current problems in applied biology and biotechnology. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 4116 OR BCHM 5124

Corequisite(s):

PPWS 5454:

Plant Disease Physiology and Development

Principles and concepts of infection and colonization of plants. Role of host's and pathogen's physiology and biochemistry in disease susceptibility and resistance, recognition, and disease specificity. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5524 (HORT 5524):

Advanced Plant Physiology and Metabolism I

Plant metabolism and its regulation, cell and organ structure and function. Current understanding of photosynthesis, respiration, nitrogen fixation, mineral nutrition, water and ion transport in plant cells and

tissues, ecophysiology and responses of plants to the environment. Pre:

undergraduate major in biology or related discipline. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5534 (APSC 5044):

Advanced Plant Physiology and Metabolism II

Presentation of the current understanding of metabolic and functional relationships among primary and secondary metabolites and storage products and their impact on the whole plant. Biosynthesis of phytohormones. Mechanisms controlling responses to phytohormones including: impact on carbon/nitrogen partitioning, senescence, development of higher plant structures such as vascular tissue and flowers. Pre: undergraduate major in Biology or related discipline. I,II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5604G:

Adv Biological Invasions

Causes, consequences, and epidemiology of invasive plants animals, and microbes. Conceptual, mechanistic, societal, and political components of invasive species from Darwin to modern day; invasion process from introduction to ecological or economic impact. Taxonomy, management, and risk assessment, within a policy context. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5624 (ENT 5624):

Animal and Plant Biosafety and Biosecurity

Principles, tools, and techniques of disease detection, early warning, and containment of animal and plant pathogens. Regulatory agencies and guidelines used to ensure the biosafety and biosecurity of the US food supply from accidental introductions and potential bioterrorism.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PPWS 5044

Corequisite(s):

PPWS 5704:

Weed Science and Management

Biological and ecological principles that influence persistence and spread of weeds. Weed genetics and the dynamics of plant species and communities, with emphasis on invasive species. Characteristics of herbicide action and metabolism that influence selectivity, resistance, and fate. Genetic engineering of herbicide resistant crops. Analysis of weed control programs for specific crops Pre: Two semesters of college biology and chemistry or two years' experience in agricultural production, industry, or policy. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5754:

Herbicide Action and Metabolism

The study of the properties and characteristics of herbicides, the fundamental processes and principles involved in their action, and their metabolic detoxification by higher plants and microorganisms. Principles of herbicide selectivity and modern approaches to increase it. II

Credit Hour(s): 3

Lecture Hour(s): 2

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): , PPWS 4754

Corequisite(s):

PPWS 5894:

Final Exam (Non-Thesis)

For students pursuing a non-thesis Master's degree, who have completed all other course work. I,II,III

Credit Hour(s): 3

Lecture Hour(s): 0

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5904:**Project and Report**

For students pursuing a non-thesis Master's degree. Projects may involve guided research or an internship. I,II,III

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s):

Corequisite(s):

PPWS 5974:**Independent Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

PPWS 5984:**Special Study**

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 5994:**Research and Thesis**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PPWS 6004:**Advanced Topics in Plant Pathology, Physiology, and Weed Science**

In depth presentations and discussions on selected advanced topics in plant pathology, physiology, and weed science. May be repeated. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PPWS 6024:**Topics in Molecular Cell Biology and Biotechnology**

Specific areas such as the molecular biology of plant and animal disease resistance, of photosynthesis, of oncogenes, of organelle assembly, and of growth and development, structure and function of polyamines and of proteases will be discussed. Students will give presentations and critically analyze current literature. May be repeated. I,II

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): BCHM 5214

Corequisite(s):

PPWS 7994:**Research and Dissertation**

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

GOVERNMENT AND INTERNATIONAL AFFAIRS

Timothy Luke, Chair

Emeriti Faculty: James Bohland; James Wolf;

Professors: Wilma Dunaway; Ilja Luciak; Timothy Luke; Joel Peters; Joyce Rothschild; Gerard Toal; Edward Weisband;

Associate Professors: Giselle Datz;

Assistant Professors: Ariel Ahram; Patricia Nickel;

Adjunct Professors: Elisabeth Chaves;

Affiliated Faculty: Matthew Dull; Randall Murch; David Orden; Georgeta Pourchot; Ioannis Stivachtis; Kris Wernstedt;

University Distinguished Professor: Timothy Luke;

Edward S. Diggs Endowed Chair in the Social Sciences: Edward Weisband;

Blacksburg: jenkin04@vt.edu

Graduate Program Director: twluke@vt.edu

National Capital Region: mlechuga@vt.edu

Graduate Program Director NCR: toalg@vt.edu

Blacksburg: <http://www.gia.vt.edu/blacksburg/>

National Capital Region: <http://www.mpia.vt.edu/index.php?page=home>

Student Handbook: <http://www.gia.vt.edu/sites/default/files/GIAHandbook.pdf>

The analysis of government and international affairs during the 21st century clearly constitutes a complex and interdisciplinary set of challenges. To be effective, such study requires knowledge from all of the social sciences and humanities. This program in the School of Public and International Affairs (SPIA) draws insights from these areas of learning into the multidimensional study of governance processes in all levels of society and international affairs. The faculty and students in the Government and International Affairs (GIA) program work jointly to cultivate their experience, knowledge, and skill with regard to the governance practices, political institutions, social dynamics, cultural values, workplace conditions, spatial formations, historical trends, and ethical conflicts that intersect in the workings of government, business, and not-for-profit organizations. Therefore, methodological pluralism is the foundation of GIA's scholarly pursuits. This program approaches the challenges of governance and international affairs comparatively, empirically, and historically at each level of activity and analysis to see how the processes of globalization are being shaped and what their implications may be. We also consider carefully the requirements for more democratic governance of the economy and society. The faculty's key educational objectives are to conduct research, perform service, and train graduate students at both the master and doctoral levels of study in a manner that can engage the GIA program as well as the larger School of Public and International Affairs at Virginia Tech in the public life of our nation and the world. Through this work, the GIA program contributes to the development of new knowledge, enhances global well-being, and prepares all its graduates with the latest skills for conducting their research, service, and teaching. The Government and International Affairs Program offers two graduate degrees: a Master's in Public and International Affairs (MPIA), and a Ph.D. in the Governance & Globalization (G&G) Stream of the Planning, Governance & Globalization Ph.D. program (PG&G), which is a wide program in which most of the departments, programs, and schools in the College of Architecture and Urban Studies now participate. The goal of these two GIA graduate programs is to prepare SPIA graduates for a life-long, rich, and full engagement in public activity, continuing professional development, and effective service as academics, government officials, journalists or technical experts in the vitally important fields of government and international affairs. The overall unifying focus of the School of Public and International Affairs is directed at issues in politics, policy, planning, and practice. GIA students will work closely with faculty and students in the school's two sister programs Public Administration and Public Policy as well as Urban Affairs and Planning and those departments in the other collegiate units at Virginia Tech that can assist them with their education.

SPECIAL FACILITIES

Computer Facilities (Blacksburg Campus): The Architecture Annex is also home to a University PC laboratory in Room 1. See http://www.lisa.stat.vt.edu/?q=computer_labs for further details.

Printing/scanning services

For printing and scanning services on the Blacksburg campus, please contact Karen Nicholson for further details. Northern Virginia Center in the National Capital Region For information on facilities at the Northern Virginia Center, please contact Myriam Lechuga for further details.

DEGREES OFFERED

MPIA Degree

Offered In (National Capital Region, Blacksburg)

TOEFL

Paper: (620.0), Essay Writing Score (4.5)

Computer: (260.0), Essay Writing (4.5)

iBT: (105.0), Essay Writing (26.0)

GRE

General: Verbal (156.0), Quantitative (157.0), Analytical (4.5)

MAXIMUM AND MINIMUM REQUIREMENTS FOR MASTERS

DEGREE Project and Report 5000-level courses (minimum*) 33 credit hours
5904 Project & Report (maximum) 3 credit hours
Thesis Option 5000-level courses (minimum*) 30 credit hours
5994 Research & Thesis (maximum) 6 credit hours
Total Hours for either Project & Report or Research & Thesis Option: 36* does not include 5904 or 5994; maximum allowed hours for 5974: 6 credit hours
All MPIA students have Thesis or Major Paper as options.

GRADUATE COURSES (GIA)

GIA 5004 (UAP 5004):

Power and Policy in the U.S.

Social science theory and research on the distribution of power in the US, especially as it shapes important national policy outcomes.

Institutional and class bases of power will be examined, including membership on corporate boards and in policy-shaping think tanks.

Implications for democracy in society will be drawn. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5034 (UAP 5034):

Democratic Governance in the Economy

An international and comparative examination of workplace and economic relations around the world, with special focus on efforts to build collaborative work processes that would extend the voice, ownership and control rights of workers. The interface between state institutions and economic organizations is also considered, especially insofar as government prescriptions and processes that may impede or extend democratic governance of the economy. Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5104:

Urban and Regional Development Theory

An examination and critique of theories relating to socio-economic development and change at three major scales (international, national/regional, and intra-urban) and of theories relating to the linkages between the dominant processes operating at these major scales. Particular emphasis is given to the role of the state in urban and regional development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5115 (PSCI 5115):

Research Methods I

The purposes, problems, and strategies of political science research, emphasizing concept and hypothesis formulation, operationalization, research design, data collection techniques, data processing, and multivariate data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5116 (PSCI 5116):

Research Methods I

The purposes, problems, and strategies of political science research, emphasizing concept and hypothesis formulation, operationalization, research design, data collection techniques, data processing, and multivariate data analysis.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5154:

Global Accountabilities

Provides a comparative perspective on "accountability" among nonprofit and non-governmental organizations, private corporations, governmental organizations, and inter-governmental organizations. Theories and practices of accountability, reporting, monitoring, compliance and learning are considered.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5164 (PSCI 5164) (UAP 5164):

Collaborative Gov

Theoretical foundations of collaborative policy and governance approaches are examined. Strategies and methods for forming and sustaining collaborative coalitions are discussed. Case studies are used to illustrate the effectiveness of collaborative approaches in different policy domains. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5214 (PSCI 5214):

Contemporary Political Theory

Selected topics in contemporary political theory, including different models of social science inquiry and the use of basic concepts like power, ideology, rationality, and the state in the study of politics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5224:

Perspectives Pol Theo

Analysis of selected perspectives on politics including rational choice theory, critical theory, neo-marxism, neo-conservatism, post-industrialism, and post-structuralism.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

539 Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5254 (PSCI 5254):

Global Conflicts

Examines theoretical issues in the study of global conflicts. Reviews theories of nationalism, states and territory as factors. Examines dynamics of contemporary conflicts from different regions of globe as case studies illustrating theoretical issues. Reviews role of leaders in conflict processes. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5274 (UAP 5274):

Comparative Social Movements

This course will investigate the forms of public protest that occur all over the world, with special attention to activism in poor nations and to the recent emergence of transnational movements. Also examines why and when governments repress social movements. Explores movements that are grounded in collective identities based in class, race/ethnicity, gender, religion, and culture. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5284 (PSCI 5284):

Transnational Migration

Overview of the dynamics, policies, governance, and citizenship regimes associated with the phenomenon of transnational migration. The course will emphasize local, national, and supranational examples and comparisons to explore these themes. Graduate standing

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5354 (PSCI 5354):

Public Policy Analysis

Approaches to policy analysis and program evaluation including the techniques appropriate to various stages of the policy process.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5364 (PSCI 5364) (STS 5364):

Public Ecology

Examines policy developments and practices that move beyond the conceptual divisions and policy operations begun during the 1970's, which largely divided the more natural science- based environmental sciences from social science-based environmental based studies. Mixes the insights of life science, physical science, social science, applied humanities, and public policy into a cohesive conceptual and operational approach to environmental protection in the 21st century. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5374 (PSCI 5374):

Electronic Governance

Examines applications of information technology in government from the point of view of governments and citizens. Survey of the relationship between e-government and e-democracy and of government management techniques. Explores problematic issues related to e-government, such as privacy, the digital divide, and information security.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5214, PSCI 5554 OR UAP 5564

Corequisite(s):

GIA 5384:

Global Economic Diplomacy

Examines dynamics of international trade, institutional structures, and treaty-based rules under which trade takes place. Economic theory of trade, multilateral governance structure of the World Trade Organization; political economy of trade negotiation; and the legal system of multilateral dispute settlement. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5404:

Topics in Political Geography

Territorial basis of political systems, political processes, and political behavior from local to global scales; evolution of contemporary political geographic patterns, territorial divisions, and process of partitioning the earth. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5414:

Industrial Democracies

Political pattern and processes of development in selected democracies in Europe, North America, and Asia emphasizing the political problems of contemporary industrial societies and their likely evolution in a "post-industrial" era.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5424:

Comm & Post-Comm Sys

Political processes and developmental trends in communist and post-communist systems in Russia and other CIS states, Eastern Europe, the People's Republic of China, and the Third World. Current economic, political, and social issues and their likely development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5434 (PSCI 5434):

Politics of Developing Areas

Political structures, economic growth, and cultural frameworks of developing nations in Asia, Africa, and Latin America emphasizing the political and economic challenges of industrial development in a global economy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5444 (PSCI 5444):

International Politics

Theories of international organizations and relations among nations focusing on research in foreign policy formulation and implementation, international integration, conflict resolution, and global political economy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5454 (PSCI 5454):

Adv Info Tech Policy

In-depth study and critical evaluation of selected complex issues related to information technology, society, governance, and public policy. Focused attention is given to theoretical and methodological foundations of the area of inquiry and to specific domains of policymaking and implementation. Topics will be selected from IT-related issues in such areas of concern as: cities, local communities, nonprofit organizations, governments, and global networks. May be repeated on a different topic. Must meet prerequisite or have permission of instructor.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5464 (UAP 5464):

Qualitative Research Methods in Global Studies

Examines the philosophies and procedures guiding various qualitative methods used in the social science fields, such as global studies, planning and policy. Exploration of alternative understandings of normal science and consideration of the merits of adopting qualitative research

approaches to disciplined analysis, including ethical issues in research.

Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5474:

Global Governance

Examination of the norms, institutions and practices developed by the international community to address systemic global governance problems: genocide, failed states, transnational corruption, displaced persons, AIDS, poverty. Role of United States in world community examined. Power of international organizations versus states. Capacity problems of both. Future of United Nations and global governance considered. Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5484 (HIST 5484) (PSCI 5484):

Contemporary American Foreign Policy

Covers U.S. foreign policy during the Cold War, the stalemate with the Soviet Union, armament and arms control, containment and deterrence, detente and Reaganism, and the end of the Cold War. Briefly covers events from 1989 to the present. Designed for students with an interest in foreign policy and global affairs. Prereqs or instructor's permission.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5214, PSCI 5444

Corequisite(s):

GIA 5504 (PSCI 5504) (UAP 5504):

Discourse Analysis

Examines the key theoretical sources and major practical applications of discourse analysis as a contemporary social science methodology.

Origins, major variants, and critical uses of discourse analysis in cultural studies, semiotic methods, policy analysis, and organizational communication techniques also are considered. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5514 (PSCI 5514):

Global Security

Security examined as an essentially contested concept. Traditional national security and emergent global security discourses and agendas explained. Security institutions and organizations analyzed. Questions of power, identity and representation examined as factors delimiting security conceptions, practices and agendas. Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): GIA 5444 OR PSCI 5444 OR UAP 5264

Corequisite(s):

GIA 5524 (UAP 5524):

Internat Development

Social and cultural factors in the development of societies, including the role of women in development. Contemporary developing countries, and historical material from developed countries; policy issues facing governments of developing countries and those interested in assisting their development.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5534 (PSCI 5534):

Regionalism and Political Development

Provides a systematic review of regional organizations, the theories and factors that explain their recent emergence and an analytical framework for studying regional policy objectives such as peace and security, economic growth, environmental protection and the pursuit of human rights. Regional variations between Europe, Latin America, Asia, Africa and the Middle East are examined.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

542 Prerequisite(s): GIA 5444 OR PSCI 5444

Corequisite(s):

GIA 5554:

Cult Pol Soc Network

Historical origins, institutional foundations, and theoretical interpretations of cultural, political, and social interaction through computer mediated communication are examined. Particular attention is given to new types of discourse, sources of power, and structures of society at all geographical levels in global computer and communications networks.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5564 (WGS 5564) (PSCI 5564):

Women and Globalization

Feminist theoretical paradigms that analyze impacts of globalization on women and girls. Impacts of globalization on households and families. Relationship between globalizing processes and gender inequalities. Addresses feminist controversies and women's transnational resistance.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5574 (PSCI 5574):

Arts, Culture and Society

Considers the role of the arts in society, including architecture, music companies, or theater productions to heritage sites, science museums, and art galleries. Effective arts policy in revitalizing urban economies also examined. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5584 (UAP 5584) (PSCI 5584):

Environmental Politics and Policy

Course provides a broad introduction to the key ideas, actors and institutions related to environmental politics and policy in the United States, with some coverage of global issues. It is intended to provide

students with basic interdisciplinary knowledge and an intellectual framework for understanding and thinking critically about environmental politics and policy.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5614 (PSCI 5614):

Understanding The Israeli Palestinian Conflict

Dynamics of the Israeli-Palestinian conflict. Critical issues that underlie the conflict and divide Israel and the Palestinians. Diplomatic efforts aimed at resolving the conflict. Pre: Graduate Standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5624:

Conflict Resolution and Peace Building

Comprehensive guide to contemporary conflict resolution. Strategies and approaches for mitigating and resolving conflict. Process of conflict transformation and reconciliation. Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5654:

Environmental Risk Analysis

This course will provide an overview of risk analysis as it pertains to environmental policy, including distinguishing among various concepts of risk, methods employed in risk analysis, public policies regarding risk analysis, the risk communication, proposed alternative approaches to risk assessment, and the political controversies surrounding risk analysis in the broad field of environmental regulation.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Corequisite(s):

GIA 5904:

Project and Report

The major paper is one option (together with the Practicum and Thesis) which GIA candidates may elect to complete their degree requirements. It provides the candidate with an opportunity to demonstrate: (1) a required degree of comprehension of the concepts, principles and theories relevant to their fields and (2) the ability to apply this understanding in a professional manner to a specific policy, planning or methodological issue by means of a sustained analytic argument. The exact character of the concerns to be examined in a major paper will be approved by a student's committee and may take the form of case studies, literature reviews, or sustained examination of policy or planning processes or outcomes.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Research, Online Research

Instruction Type(s): Research, Online Research

Prerequisite(s): GIA 5014, GIA 5214 OR UAP 5144

Corequisite(s):

GIA 5914:

Peace Corps Service Credits

Critical evaluation and field-based study of selected complex issues related to society in international context; study of cultural and language diversity; approaches to ethnoinclusiveness in urban and rural environments; focus on practical local and regional planning for the benefit of local communities in consort with nonprofit organizations, governments and global networks. Pre-requisite: Graduate Standing and enrollment in Masters Internation Program and Peace Corps.

Credit Hour(s): 6

Lecture Hour(s): 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

GIA 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

GIA 6114 (PSCI 6114):

Critical Geopolitics

Critical analysis of geopolitics as spatial discourse about world politics. Examines major concepts in critical geopolitics. Critically reads colonial, fascist, Cold War and post-Cold War geopolitical discourses. Discusses geopolitical knowledge in popular culture. Reviews latest research in the field of critical geopolitics. Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): PSCI 5444

Corequisite(s):

GIA 6124:

Topics in Security Studies

Surveys the interface of globalization and security and the changing paradigm of security within global society. Reviews the impact of globalization on traditional understandings of state security, and provides an advanced understanding of the emerging challenges and threats to human and state security. May be repeated with a different topic content for a maximum of 12 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): GIA 5444 OR PSCI 5444 OR GIA 5514

Corequisite(s):

GIA 6134:**Topics in Conflict Analysis**

Provides a comprehensive guide to the understanding of contemporary global conflicts and conflict resolution. Reviews the field of conflict analysis, demonstrates the various approaches to conflict resolution and explores the dynamics of conflict settlement. May be repeated with a different topic content for a maximum of 12 credits.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5254 OR UAP 5254 OR PSCI 5254

Corequisite(s):

GIA 6144:**Topics in Global Governance**

Provides a comprehensive guide to understanding of contemporary power pressures and responses to global economic and financial change along with its political and social repercussions. Reviews the fields of international political economy, demonstrates the various approaches to adherence and resistance to globalization, and explores the dynamics of the relationship between states and markets. May be repeated with a different topic content for a maximum of 12 credits.

Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5034 OR UAP 5034 OR PSCI 5034

Corequisite(s):

GIA 6204:**Theories in Globalization**

Examination of past and present eras of globalization through various theoretical perspectives. Addresses colonialism and emergence of western models for development of poor countries. Controversies about impacts of current globalization on the nation-state, cultures, ecosystems, and racial/ethnic/gender inequalities. Explores present trends, such as globalization of agriculture and food systems, industrial production, migration, human rights, and anti-globalization resistance.

Pre-requisite may be substituted for any equivalent 5000 level international course.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): UAP 5264 OR GIA 5264

Corequisite(s):

GIA 6214 (PSCI 6214):**Democracy Beyond the Ballot**

Forms of ultra or enhanced democracy outside of state institutions, particularly those developing in third sector organizations, theories of democracy and research on functioning deliberative democracies at the grassroots level, in societal or international institutions. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5034 OR UAP 5034 OR PAPA 5034 OR GIA 5164 OR UAP 5164

Corequisite(s):

GIA 6224 (PSCI 6224):**Competing Conceptions of the Third Sector**

Competing theories and conceptions of the third sector in relation to the for-profit firm and the state with international perspectives on voluntary grassroots action challenges and societal transformation. Integration of theoretical and research literatures in the field. Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): GIA 5034 OR UAP 5034 OR PAPA 5034 OR GIA 5164 OR UAP 5164

Corequisite(s):

GIA 6234:**Political Geography of AIDS**

Impact of AIDS in terms of scientific, demographic, cultural, and social geographies, particularly how inequalities of power affect populations with AIDS. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

GIA 6984:**Special Study**

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

GIA 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

FOREST PRODUCTS

Audrey Zink-Sharp, Associate Head

Robert Smith, Head

Professors: Robert Bush; Kevin Edgar; Charles Frazier; Barry Goodell; A Hammett; David Kline; Joseph Loferski; Robert Smith; Paul Winistorfer; Audrey Zink-Sharp;

Associate Professors: Brian Bond; Urs Buehlmann; Daniel Hindman; Henry Quesada Pineda; Maren Roman;

Assistant Professor of Practice: Laszlo Horvath; Young Teck Kim;

General Contact: garnandd@vt.edu

Student Handbook: <http://www.sbio.vt.edu/students/graduate/>

The Department of Sustainable Biomaterials is one of the leading academic programs in North America. We support a large graduate education program where students are engaged in research. Because of the nature of wood as a material, we have considerable interaction in our graduate education and research endeavors with other departments, colleges, centers and institutes on the Virginia Tech campus. Our faculty expertise is diverse and experienced in support of our graduate education mission. We provide educational and research opportunities in the areas of wood science and forest products, spanning the range from nanotechnology and the basic science of wood as a material, through processing, manufacturing, marketing, management, and competitiveness aspects of the forest products industry. Some of our research is done in concert with our faculty-directed research centers and is supported by these Centers and their external cooperators. General areas of degree specialization within our graduate program include: Forest Products Marketing, Non-Timber Forest Products, Packaging Science, Pallet and Container Design, Wood Engineering, Wood Performance in Structures, Wood Composites, Wood Adhesion, Wood Formation, Cell Wall Architecture, Bio-Materials, Lumber Drying and Processing, Lean Manufacturing, Wood Industry Management, Packaging for Modern Supply Chains, Packaging and Unit Load Design

SPECIAL FACILITIES

Excellent laboratory and classroom resources are available for education, research, and teaching in Blacksburg, Virginia and other locations across Virginia. Faculty, staff, and student researchers have access to research laboratories in several locations, principally Cheatham Hall on the main campus in Blacksburg and the Brooks Forest Products Center located approximately 1.5 miles from the main campus in the Virginia Tech Corporate Research Center. Cheatham Hall has space for research, education, and application short courses plus forestry research laboratories and college-wide computing facilities. Our laboratories have capabilities for liquid and gas chromatographic separation of wood components, thermal analysis of cellulose materials, molecular weight determination, nuclear magnetic resonance, dynamic mechanical analysis, FT-IR and UV-VIS spectroscopy, contact angle analysis, light and electron microscopic study of structure and properties, and wide-angle X-ray diffraction for crystallinity and microfibril angle analysis. The Brooks Center has classrooms, offices, and laboratories for the manufacture of pressed panels, several engineering testing machines, wood and metal working shops, pallet and container research facilities, packaging research equipment, and other wood and fiber-based composite testing instrumentation.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

The department offers three degrees: Master of Forestry (M.F.), Master of Science (M.S.) in Forestry and Forest Products, and Doctor of Philosophy (Ph.D.) in Forestry and Forest Products. The M.S. and Ph.D. degrees require students to prepare a thesis or dissertation, and considerable time spent working for these degrees is devoted to research. The M.F. degree is a professional, non-research degree for those who wish to expand their post-baccalaureate education. Master of Forestry The M.F. is a non-research degree intended to serve the needs of (1) those who have a prior wood science and forest products degree and who wish to enhance their knowledge and skills, or (2) those who have no previous degree in wood science and forest products. In addition to formal course work at the graduate and senior undergraduate levels that is commensurate with the objectives of the student's degree program, a substantive paper worth three to six hours of academic credit is required. A minimum of 33 credit hours in formal course work, inclusive of hours credited towards the degree paper, must be passed with a minimum GPA of 3.0 for courses in the program of study. The M.F. student must pass a comprehensive oral examination covering his/her course work and the degree paper. All Graduate School requirements apply as to the nature and timing of the candidate's final examination. Master of Science The M.S. is a research-based degree. Students work closely with a faculty advisor and graduate committee on original research. Advanced coursework is expected in the areas of expertise required to complete the research project. Students complete a thesis and are expected to publish their research results in peer-

reviewed scientific journals at the completion of their degree. Graduates are prepared to continue their professional careers or undertake further study through a Ph.D. program. All Graduate School requirements apply regarding the number of credits and level of courses required on a student's Plan of Study. M.S. students must complete a research working plan by the end of the second academic semester. Guidelines for the preparation and submittal of the working plan are listed in the College of Natural Resources & Environment (CNRE) Graduate Program Procedures. M.S. students must pass a final exam. The examination will be a defense of the thesis and an assessment of the student's understanding of appropriate forestry-related subjects. Doctor of Philosophy Each Ph.D. student must complete a minimum of 90 credit hours of graduate study and a dissertation. The Plan of Study must meet minimum Graduate School requirements; in addition, a student's advisory committee may add specific requirements needed for an individual student's academic development. Ph.D. students must complete a research working plan by the end of the third academic semester. Guidelines for the preparation and submittal of the working plan are listed in the College of Natural Resources & Environment (CNRE) Graduate Program Procedures. A preliminary exam, oral and/or written, is conducted by the student's advisory committee. It is comprehensive in nature and is intended to test a student's ability to integrate, synthesize, and apply concepts, facts, and techniques in solving new and complex problems associated with forest management and use. The student may be tested on any aspect of forest science, the philosophy of science, and research methodology. The final exam is primarily a defense of the dissertation, but other areas of science may be included. Ph.D. students are expected to publish their research results in peer-reviewed scientific journals at the completion of their degree.

MS Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

All program degree requirements and supplemental information about graduate education in our department is summarized in our annually updated Graduate Student policy and Procedures manual, available online on our department website. This manual describes all required coursework, requirements and activities associated with graduate education in our department. The department offers three degrees: Master of Forestry (M.F.), Master of Science (M.S.) in Forestry and Forest Products, and Doctor of Philosophy (Ph.D.) in Forestry and Forest Products. The M.S. and Ph.D. degrees require students to prepare a thesis or dissertation, and considerable time spent working for these degrees is devoted to research. The M.F. degree is a professional, non-research degree for those who wish to expand their post-baccalaureate education. Master of Forestry The M.F. is a non-research degree intended to serve the needs of (1) those who have a prior wood science and forest products degree and who wish to enhance their knowledge and skills, or (2) those who have no previous degree in wood science and forest products. In addition to formal course work at the graduate and senior undergraduate levels that is commensurate with the objectives of the student's degree program, a substantive paper worth three to six hours of academic credit is required. A minimum of 33 credit hours in formal course work, inclusive of hours credited towards the

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MF Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

Computer: (213.0)

iBT: (80.0)

GRE

General Test: Verbal, Quantitative, Analytical

All program degree requirements and supplemental information about graduate education in our department is summarized in our annually updated Graduate Student policy and Procedures manual, available online on our department website. This manual describes all required coursework, requirements and activities associated with graduate education in our department. The department offers three degrees: Master of Forestry (M.F.), Master of Science (M.S.) in Forestry and Forest Products, and Doctor of Philosophy (Ph.D.) in Forestry and Forest Products. The M.S. and Ph.D. degrees require students to prepare a thesis or dissertation, and considerable time spent working for these degrees is devoted to research. The M.F. degree is a professional, non-research degree for those who wish to expand their post-

baccalaureate education. Master of Forestry The M.F. is a non-research degree intended to serve the needs of (1) those who have a prior wood science and forest products degree and who wish to enhance their knowledge and skills, or (2) those who have no previous degree in wood science and forest products. In addition to formal course work at the graduate and senior undergraduate levels that is commensurate with the objectives of the student's degree program, a substantive paper worth three to six hours of academic credit is required. A minimum of 33 credit hours in formal course work, inclusive of hours credited towards the degree paper, must be passed with a minimum GPA of 3.0 for courses in the program of study. The M.F. student must pass a comprehensive oral examination covering his/her course work and the degree paper. All Graduate School requirements apply as to the nature and timing of the candidate's final examination. Master of Science The M.S. is a research-based degree. Students work closely with a faculty advisor and graduate committee on original research. Advanced coursework is expected in the areas of expertise required to complete the research project. Students complete a thesis and are expected to publish their research results in peer-reviewed scientific journals at the completion of their degree. Graduates are prepared to continue their professional careers or undertake further study through a Ph.D. program. All Graduate School requirements apply regarding the number of credits and level of courses required on a student's Plan of Study. M.S. students must complete a research working plan by the end of the second academic semester. Guidelines for the preparation and submittal of the working plan are listed in the College of Natural Resources & Environment (CNRE) Graduate Program Procedures. M.S. students must pass a final exam. The examination will be a defense of the thesis and an assessment of the student's understanding of appropriate forestry-related subjects. Doctor of Philosophy Each Ph.D. student must complete a minimum of 90 credit hours of graduate study and a dissertation. The Plan of Study must meet minimum Graduate School requirements; in addition, a student's advisory committee may add specific requirements needed for an individual student's academic development. Ph.D. students must complete a research working plan by the end of the third academic semester. Guidelines for the preparation and submittal of the working plan are listed in the College of Natural Resources & Environment (CNRE) Graduate Program Procedures. A preliminary exam, oral and/or written, is conducted by the student's advisory committee. It is comprehensive in nature and is intended to test a student's ability to integrate, synthesize, and apply concepts, facts, and techniques in solving new and complex problems associated with forest management and use. The student may be tested on any aspect of forest science, the philosophy of science, and research methodology. The final exam is primarily a defense of the dissertation, but other areas of science may be included. Ph.D. students are expected to publish their research results in peer-reviewed scientific journals at the completion of their degree.

GRADUATE COURSES (SBIO)

SBIO 5004:

Forest Products Graduate Seminar

Gives graduate students experience in presenting results or reviews of forest products and wood science topics. The course also provides opportunities for students to learn about recent developments in forest products from invited speakers. I,II

Credit Hour(s): 1

Lecture Hour(s): 1

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5124:

Wood Material Science

Advanced and comprehensive treatment of wood material science including wood anatomy and formation, mechanical and physical properties, and wood polymer science.

Credit Hour(s): 4

Lecture Hour(s): 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5224:

Quantitative Wood Anatomy

Formation, composition, and arrangement of the anatomical elements of tree stem wood. Preparation methods and examination of wood and wood fiber with light and scanning electron microscopy and select methods for quantitative characterization of wood anatomical structure.

Pre-requisite: Graduate Standing required

Credit Hour(s): 2

Lecture Hour(s): 1

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5314:

Physical and Mechanical Behavior of Wood

Physical and mechanical properties of wood. Thermodynamics and theories of moisture sorption and measurement. Hygroexpansion. Transport of fluids, heat, and electricity. Orthotropic elasticity and structure. Mechanics of solid wood axial, bending, and torsion elements. Failure mechanisms, rheological behavior, and environmental effects. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): SBIO 4316

Corequisite(s):

SBIO 5324:

Rationale behind current design procedures for wood structures and components. Advanced topics such as reliability-based design, fracture mechanics, cumulative damage theory, and the effects of a changing resource and technology base. I

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): null null

Corequisite(s):

SBIO 5384G:

Advanced Biorefinery Science

Biomass utilization as an industrial resource. Biorefinery processes such as cultivation, harvesting, separation, and biomass processing in to 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-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5414:

Advanced Wood Chemistry and Structure

Structure and ultrastructure of wood. Chemical properties and reactions of tree constituents. Non-destructive methods for wood (and plant) analysis. Description of processes for the selective removal of wood components. Biotechnological applications for wood and biomass. I

Credit Hour(s): 0 OR 4

Lecture Hour(s): 0 OR 3

Instruction Type(s): Lab, Lecture

Instruction Type(s): Lab, Lecture

Prerequisite(s): SBIO 3224

Corequisite(s):

SBIO 5424 (CHEM 5424):

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. Graduate standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): (CHEM 2565 (UG) OR CHEM 2565), (CHEM 2566 (UG) OR CHEM 2566) OR (CHEM 2514 (UG) OR CHEM 2514)

Corequisite(s):

SBIO 5614:

Forest Products Marketing and Management Strategies

Examination of forest products markets, industry structure, distribution channels, and strategic management trends. Case studies demonstrate the impact of these factors on decision-making in the forest products industry. II

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): SBIO 4614 OR FOR 3424

Corequisite(s):

SBIO 5894:

Final Examination

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5954:

Study Abroad

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

549 Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

SBIO 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

SBIO 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

SBIO 7994:

Research and Dissertation

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

BIO-INSPIRED BUILDINGS

General Contact: howardl@vt.edu

Graduate Site: <http://biobuild.mlsoc.vt.edu>

We propose to develop a doctoral program that answers the pressing societal need for professionals with the interdisciplinary expertise necessary to create buildings and communities that are in fact bioinspired. Such graduates will have an immediate impact in university and industrial settings, and they will change the relationship between the built environment and our planet. We will do this through a radical shift in how we understand buildings by bringing together faculty from departments in CAUS, CNRE, COE and COS and collaborating with interdisciplinary university centers such as the CMI, to develop a program that explores building systems and biological systems synergistically to discover innovative connections between these two fields. The specific goals are to: (1) create and sustain a PhD program at the confluence of buildings and biology whose students will undergo a

transformation as they progress from a disciplinary perspective to one where their views are naturally and inherently tied to the phenomena and tools that they have studied in an interdisciplinary environment; (2) produce graduates who obtain highly competitive academic and industry positions because their abilities to view grand challenges in the built and natural environments through an interdisciplinary lens gives them a competitive edge; and (3) place Virginia Tech as a global thought leader in this emerging area. Colleges and Departments: College of Architecture & Urban Studies Myers-Lawson School of Construction Building Construction School of Architecture and Design College of Science Biological Sciences College of Engineering Mechanical Engineering Civil and Environmental Engineering Engineering Science and Mechanics College of Natural Resources and Environment Forest Resources and Environmental Conservation Sustainable Biomaterials For more information please contact Dr. Michael Garvin at garvin@vt.edu

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

COMPUTATIONAL TISSUE ENGINEERING

Padma Rajagopalan: padmar@vt.edu

The goal of the Computational Tissue Engineering (CTE) Interdisciplinary Graduate Education Program (IGEP) is to exploit the natural synergy and to define a new synthesis between tissue engineering and systems biology. We propose to use the computational sciences to drive this synthesis. In our vision, seamlessly intertwined computational and experimental models will drive the next generation of advances in tissue engineering and in systems biology. Systems biology approaches will underlie predictive computational models of engineered tissues and drive novel experimental analyses of engineered tissues, while the demands of tissue engineering will inspire new experimental methods in systems biology and novel analysis frameworks in computational science. We will train students at the confluence of tissue engineering, molecular and cell biology, and computational science. Our vision is that trainees will emerge as the leaders of the new trans-disciplinary field of "Computational Tissue Engineering". They will be equipped to lead and develop this new field, have the training to span traditional disciplinary boundaries, and to converse in the languages of tissue engineering, molecular and cellular biology, and computational science with ease. Colleges and Departments: College of Engineering Chemical Engineering Computer Science Biomedical Engineering and Sciences College of Science Biological Sciences College of

Agriculture and Life Sciences BiochemistryCollege of Veterinary
Medicine Biomedical Sciences and PathobiologyCollege of Liberal Arts
and Human Sciences Science and Technology in SocietyFor more
information please contact: Padma Rajagopalan, Principal Investigator,
padmar@vt.edu

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

CREATIVE TECHNOLOGIES

Kevin Concannon, Head

Professors: Carol Burch-Brown; Kevin Concannon;

Associate Professors: Simone Paterson; Eric Standley; Thomas Tucker; Dane
Webster;

Assistant Professors: Troy Abel; Samuel Blanchard; Meaghan Dee; Hans
Gindlesberger; Travis Head;

Affiliated Faculty: Ivica Bukvic; Yong Cao; Richard Knapp;

Graduate Contact: webster@vt.edu

General Contact: rcallah@vt.edu

Creative Technologies MFA Program: <http://www.ctmfavt.com/>

School of Visual Arts: <http://www.sova.vt.edu/>

The Master of Fine Arts (MFA) in Creative Technologies in the School of Visual Arts (SOVA) is a professional, terminal degree program that prepares students to use digital and new media technologies to create, present, communicate and shape information and imagery. Primary emphasis is in animation, interactivity, and data visualization. The program addresses emerging trends in the use of these tools in scientific and research arenas, art and design, and industrial/commercial contexts. Based in visual arts and design, the Creative Technologies program is cross-disciplinary and inter-media. Faculty work with students on an individual basis to design a unique program of study and research which culminates in a thesis project. Students integrate original work across a spectrum of modalities, including 3D animation, motion graphics, digital imaging and video/audio, interactive environments, and creative coding. The MFA program connects students with faculty, research, and courses not only in SOVA but also in Computer Science, Music, Engineering, Human Centered Design, and a host of other programs at the intersection of arts, design, engineering, sciences, and cultural issues. We are integrally related to the projects

and faculty of the Institute for Creativity, Arts, and Technology. MFA students in SOVA build unique connections with technology-based faculty in art and design that bridge out to the larger community of creative researchers, educators, and commercial/industrial practitioners. On average, the full time student will complete the program in two and half to three years. Students entering with significant prior experience in their chosen areas and with a strong digital design background may be able to complete the program in less time. Application DeadlineThe application deadline for the MFA is February 14. Please go to the MFA in Creative Technologies website for more info and here for a pdf with specific instructions. We generally accept students starting at the beginning of each fall semester (no rolling admissions).

SPECIAL FACILITIES

The School of Visual Arts Studios are located in several different buildings. Designated Graduate Research Space is provided for MFA students in the SOVA Studios.The Art Armory is home to the school's main office, gallery, and studios for Drawing and the Foundations Program. One of Blacksburg's historic buildings and a former community gymnasium it is situated on Draper Road, a lively intersection of the town and campus. The Armory Art Gallery is operated as an educational and outreach service of the University. Its exhibition calendar includes work by visiting artists (national and regional), faculty, and students. XYZ Gallery, located at 221 N. Main St., is home to the Student Art Association, which operates an independent program of exhibitions by students and local artists.DAAS LabA core facility for MFA students is the Digital Arts and Animation Lab (DAAS), centrally located in Blacksburg's downtown area and arts district. DAAS provides students with the high-end tools used throughout industry in the production of digital film, motion graphics, interactive media, and animation content. The lab contains 15 Mac Pro workstations with large 24-30 inch monitors and loaded with professional industry applications, including Maya, ZBrush, Max/MSP/Jitter, and Unity. The facility also has a render farm of Mac Pros with over 80 cores.Henderson Hall houses the Visual Communication Design program (undergraduate) and Art History, as well as a studio for certain creative technologies courses. Four Design (SOVA's professional internship program for undergraduates) and GlyphX (SOVA's professional printing service center) are located in Henderson.The Art & Design Learning Center (ADLC) is the location for SOVA studios in Painting, Sculpture, and Ceramics. The Sculpture studio maintains a strong focus on digital fabrication/prototyping and also includes a full wood shop.Equipment and Tools for creative projects based in digital technologies include: FARO Focus 3D Laser Scanner Shopbot 96"x48" CNC Router Makerbot Replicator OptiTrack Motion Capture System (through ICAT) 2 Universal Laser Systems 18"x32" Laser Cutter Digital SLR and Video Cameras Digital Recorders Midi controllers Small electronics, sensors, microcontrollers College-level facilities include the Art + Architecture Library in Cowgill Hall. SOVA facilities and equipment are augmented by the diverse array of spaces and equipment available to MFA students for research projects through ICAT. These include the "Living Labs," a group of distinctive spaces equipped and dedicated to innovative experimental inter-media arts and research projects: The Cube, Experience Studio, Sandbox, Merryman Family Learning Studio, Perform Studio, and Create Studio.MFA students have access to Innovation Space in Torgersen Hall, a well equipped public digital laboratory for video and audio editing, as well as a source for short term, free use of high end cameras, audio kits, and other equipment.

Facility Web Resources

Links to some SOVA facilities and to related centers.

DEGREES OFFERED

MFA Degree

Offered In (Blacksburg)

IELTS
TOEFL

Paper: (550.0)

iBT: (80.0)

The MFA in Creative Technologies requires 60 graduate credit hours, including a thesis project. The credit hours are distributed as follows: 30 credit hours in digital studios, projects, labs, and internships 9 in art history / theory courses, including graduate seminar 9 in electives outside of the School of Visual Arts 12 in thesis project, culminating in a public event, exhibition, app, or other mode appropriate to the project. Professional internships are strongly encouraged and up to 12 credit hours of studio / lab may be used for well designed internships on or off campus. In addition to the 60 credit hours students may be required to take certain courses to strengthen their background in specific areas, as determined by the MFA faculty. These courses do not count toward the 60 hour Plan of Study, but do count toward full time status and graduate assistantships.

Degree Concentrations:

While we do not have pre-defined curricular tracks students can develop their Plan of Study to concentrate in data and spatial visualization; creative coding for art and design; 3d animation and gaming; and interactive environments. Most students will combine elements of each of these as they develop a path that is uniquely tailored to their interests and goals.

DISASTER RESILIENCE

Professors: Christopher Zobel;

Associate Professors: Robert Weiss;

Assistant Professors: Margaret Cowell; Yang Zhang;

Research Assistant Professors: Celal Olgun;

General Contact: czobel@vt.edu

Graduate Site: <http://www.czobel.bit.vt.edu/resilience-igep>

Interdisciplinary efforts to build resilience to disasters have not succeeded as desired. Although we now have better models, better technology and better communication, our vulnerability to disaster and risks continues to grow. One of the key reasons for this is the way we live. Concentrations of people, power, technology, education, and knowledge lower resilience and create more complex connections that can be disrupted. Virginia Tech's Interdisciplinary Graduate Education

Program in Disaster Resilience is working to improve disaster resilience and sustainability by changing the interdisciplinary paradigm. Instead of feeding information and experience into a core of knowledge, the Disaster Resilience-IGEP's goal is to have the disaster perspective inform the disciplines. We are tapping the power of scenarios to create a shared experience among many disciplines. This experience will help shape a perspective of resilience that informs everyday decisions in widely distributed activities. The primary goal of our collaborative effort is to prepare graduate students to become thought leaders in promoting resilience concerns in a wide variety of disciplines. Focusing on the trans-disciplinary paradigm, our effort leverages the strengths of several world-class academic units at Virginia Tech to produce a well-rounded perspective and understanding of the full complexity of disaster risk, resilience, and mitigation. Our approach concentrates on investigating the main drivers of vulnerabilities, recognizing their complex interactions, and generating informed risk minimization strategies. The current departments and colleges at Virginia Tech from which the core faculty in the program are as follows: Business Information Technology (in the College of Business) Civil and Environmental Engineering (in the College of Engineering) Geosciences (in the College of Science) Urban Affairs & Planning (in the College of Architecture and Urban Studies) New students can be admitted directly into the Interdisciplinary Graduate Education Program in Disaster Resilience, but they will transition into one of the participating academic departments for their core coursework and degree completion, while continuing to participate in Program activities. The Disaster Resilience program does not currently offer a dedicated graduate degree.

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (National Capital Region, Blacksburg)

The Interdisciplinary Graduate Education Program in Disaster Resilience does not currently offer a dedicated graduate degree. Participants will participate in interdisciplinary program activities such as seminars and workshops, but will work towards receiving a PhD degree from one of the following core participating departments: Business Information Technology (in the College of Business) Civil and Environmental Engineering (in the College of Engineering) Geosciences (in the College of Science) Urban Affairs & Planning (in the College of Architecture and Urban Studies)

HUMAN CENTERED DESIGN

Troy Abel, Program Director

Associate Professors: Michael Evans; Matthew Wisnioski;

Assistant Professors: Troy Abel;

General Contact: tabel@vt.edu

Graduate Site: www.hcd.icat.vt.edu

Human Centered Design (HCD) is an emerging design philosophy

charged with understanding the processes and methodologies in which the needs, wants, and limitations of end-users are integrated at every stage of the design process. HCD can be characterized as a multi-stage process of problem definition and solution that not only requires designers to analyze and foresee how users are likely to use a product, but also to test the validity of their assumptions with regards to user behavior in real world tests with actual users. HCD creates novel learning and discovery opportunities that are needed to train the future professoriate, workforce, and professional / civic leaders. HCD, however, can only be taught in a true interdisciplinary educational environment in which coursework and research embrace diversity, inclusiveness, educational breadth, and interdependence, while promoting a person-oriented, rather than a product-oriented, attitude towards education. We propose both a PhD program and a graduate certificate in a curriculum that combines technical expertise with critical inquiry to develop reflective practitioners equipped to meet vital human needs. The HCD/IGEP degree is build around competencies in four core areas: (1) Creative Problem Solving, (2) Computational Practices, (3) Interdisciplinary Research, and (4) Humane Understanding. Colleges and Departments: College of Architecture & Urban Studies Industrial Design School of Architecture and Design School of Visual Art College of Engineering Computer Science Engineering Education Mechanical Engineering College of Liberal Arts and Human Sciences English Learning Sciences and Technology – School of Education Science and Technology in Society Institute: Institute for Creativity, Art, and Technology (ICAT) For more information please contact Dr. Troy Abel at tabel@vt.edu

SPECIAL FACILITIES

DAAS

DAAS : Digital Arts and Animation Lab The new Digital Arts and Animation Lab (DAAS) is centrally located in Blacksburg's downtown area. This facility provides students with the high-end tools used throughout industry in the production of digital film, web, and animation content. The lab contains 16 Mac Pro workstations with large 23-inch monitors and loaded with professional industry applications, like Final Cut Pro and Maya. The facility also has an additional small render farm of six 12-core Mac Pros and a state-of-the-art ABS Rapid Prototyper, used for outputting virtual models into Three-Dimensional forms for research and educational purposes.

DISIS

DISIS: Digital Interactive Sound and Intermedia Studio DISIS, founded in 2007 by Dr. Ivica Ico Bukvic, complements and recontextualizes the Virginia Tech music technology program by providing the rapidly growing Creative Technologies in Composition and Multimedia Art Design option. By coupling contemporary technology with traditional performance idioms, DISIS pursues a symbiosis of new forms of artistic expression with special focus on interactive multimedia art and scientific research of new multimedia technologies for the purpose of betterment of the overall quality of life.

ETUT

ETUT: Eye-Tracking and Usability Testing Lab ETUT uses state-of-the-

art SMI products including the RED X 120Mhz stationary eye-tracking camera systems, as well as the new SMI ETG (Eye Tracking Glasses) portable on-site tracking system. In addition to eye-tracking a multitude of stimuli (static images, video, websites, mobile applications, etc.) ETUT provides complete holistic usability evaluation services on par with industry standards with academic innovation.

ICAT

ICAT: Institute for Creativity, Arts, and Technology Located at the very crossroads of Virginia Tech and downtown Blacksburg, on the corner of Main Street and Alumni Mall, the Center for the Arts' facilities provide a community center in the grandest sense, a place where the arts are a catalyst for engagement, inspiration, and discovery. New facilities complement existing venues, and are located in close proximity to Henderson Hall, Theatre 101, Squires Student Center, the Armory Gallery, and the Lyric Theatre forming a prominent arts district. The center's 150,000-square-foot facility includes the four-story experimental "Cube" for performance, immersive environments, installation, and adjacent research studios.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

INDIVIDUAL INTERDISCIPLINARY PHD

Karen DePauw, Head

Karen DePauw: kdpauw@vt.edu

Maura Borrego: mborrego@vt.edu

Interdisciplinary graduate Education: interdisciplinary.graduateschool.vt.edu

The Individual Interdisciplinary Doctoral Program (ID PhD) is designed to prepare exceptional graduate students who wish to pursue and attain an individually customized interdisciplinary doctoral degree. The purpose of the ID PhD is to provide an option for highly qualified students whose educational goals are uniquely interdisciplinary and cannot be met by a single discipline from a degree granting academic unit at Virginia Tech. The ID PhD offers a distinctive opportunity for students seeking a breadth of knowledge, in addition to disciplinary depth, not available within one discipline. The ID PhD program is intended for doctoral training requiring participation, collaboration, and integration from two or more academic units representing different disciplines.

SPECIAL FACILITIES

The Individually Designed PhD program is housed in the Graduate School located in the Graduate Life Center.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

For successful admission to and completion of the ID PhD program at Virginia Tech, the student must demonstrate the need for the interdisciplinary research project and identify a major professor and advisory committee members who will provide the appropriate guidance for a unique project. A prospective student who wishes to pursue the ID PhD degree must be near completion or have completed a master's degree. Prospective students without a master's degree may be approved by the Vice President and Dean of the Graduate School to submit an application under special circumstances. Because of the rigor and intensity of the ID PhD program, a graduate GPA of 3.5 or higher is required. The Graduate School will administer the ID PhD program for highly motivated students in excellent academic standing whose primary education and research goals are truly interdisciplinary such that no single discipline or degree granting unit can accommodate the students' scholarly pursuits. The ID PhD program is specifically designed for students who will seek to study across two or more disciplines in a combination not available through a degree granting program. Like all doctoral students, the ID PhD students will be closely supervised by the major professor and at least three advisory committee members. Admission to the ID PhD is highly selective because the Graduate School will expect completion of an especially rigorous set of courses and dissertation research project for this degree. The application process involves two steps: (1) Identification of a major professor and potential advisory committee members. A prospective graduate student from an outside institution must schedule a visit to VT to consult with faculty interested in sponsoring the student's proposed program of study and dissertation proposal prior to submission of the application. (2) Application to the Graduate School for admission to the ID PhD program. The student may identify an existing Interdisciplinary Graduate Education Program (IGEP) of interest or apply for a unique degree focus. Applications to the ID PhD are evaluated once a year for fall semester admission in accordance to the Graduate School guidelines and requirements for admission to graduate programs. In addition, applicants must submit the following application materials to the Associate Dean and Director of Interdisciplinary Graduate Education: If required by any of the academic units with which the student will be working, the results of standardized tests such as GRE or GMAT. International students must submit acceptable TOEFL (iBT = 80 total and 20 on each subtest) or IELTS (6.5) scores or otherwise satisfy Graduate School requirements for competency in English (e.g., earned a degree from an international university that provides all instruction in English). A letter from a VT faculty advisor describing the student's potential for success and ability to conduct independent interdisciplinary research, and expressing willingness to chair the student's advisory committee and provide funding for tuition and stipend. Letters or email messages from 3-4 tenure-track VT faculty members willing to serve on the student's advisory committee. Three letters of recommendation from faculty commenting on the student's ability to pursue an interdisciplinary doctoral degree. At least one example of scholarly writing (e.g., introduction and conclusion of master's thesis, published research paper). Student's statement of career goals and rationale for pursuing the ID PhD degree. Description of the interdisciplinary study and research plans including Interdisciplinary program title Advisor and advisory

committee members, including identification of areas of expertise relevant to the proposed research program showing integration across various disciplines. Completed and current coursework (transcripts). Coursework plan of study for the ID PhD degree. Preliminary examination topic areas from disciplines involved in the interdisciplinary program. Timeline from enrollment to graduation. Description of previous research experience and projects. Description of the proposed interdisciplinary research (500 words). The Graduate School does not provide funding to support students earning the ID PhD. Students are encouraged to seek funding through faculty grants, departmental funds, and/or other funding opportunities such as scholarships and fellowships from VT or external sources.

INTERFACES OF GLOBAL CHANGE

hopkinsw@vt.edu; jrwalt@vt.edu

General Contact: schoeng@vt.edu

Primary Site: <http://globalchangephd.com/>

The five greatest anthropogenic threats to global health and biodiversity include habitat loss, pollution, climate change, disease, and the introduction of non-native species. Although there is considerable research on each of these individual global threats, much less is known regarding how these factors interact with one another. For example, how can climate change affect the distribution of invasive species that are important vectors of disease? These types of interactions are critical because all habitats experience the simultaneous pressure of two or more of these threats. Looking to the future, a more interdisciplinary understanding of these anthropogenic factors is necessary to inform public policy, minimize further environmental degradation and loss of biodiversity, and to promote sustainable solutions to the greatest environmental challenges of the 21st century. The Interfaces of Global Change (IGC) program is an interdisciplinary graduate education program designed to address the multidimensional aspects of global change. Funded by the Virginia Tech Graduate School, this program is one of several Interdisciplinary Graduate Education Programs (IGEPs) on campus that address a major fundamental problem or complex societal issue requiring an interdisciplinary team of scholars. Participants (PhD Fellows) will enter the program at the beginning of their graduate studies and continue to participate throughout their time at Virginia Tech. The goals of the IGC IGEP are to provide each PhD Fellow with a broad perspective on how the five major global changes interact to impact biodiversity and environmental health. The societal causes and consequences of these ecological problems. The role that science can play in resolving these issues by informing sound environmental policy. The Interfaces of Global Change IGEP is not a degree-granting program. Rather, it will provide PhD students with a unique intellectual focus and training. Our goal is for each IGC Fellow to gain depth in their specific scientific area of expertise (e.g. biology or engineering), while simultaneously gaining breadth in the multifaceted realm of global change and the science-policy interface. Students still receive their PhD degree from their home department, but they will participate in a slightly different curriculum that will focus on global change. Our 18 core faculty members represent a diversity of scientific and societal perspectives as well as a community of scholars spanning all stages of their academic career. We represent 10 departments and 6 colleges on campus, and one off-campus center, with strong inclusion of both the sciences and social sciences. Reaching across so many academic units is required to

achieve our vision for interdisciplinary training. Colleges and Departments College of Agriculture and Life Sciences Entomology Plant Pathology, Physiology & Weed Science College of Engineering Biological Systems Engineering Civil and Environmental Engineering College of Liberal Arts and Human Sciences Department of History College of Natural Resources and Environment Fish & Wildlife Conservation Forest Resources and Environmental Conservation Virginia Water Resources Research Center College of Science Biological Sciences Geosciences College of Architecture and Urban Studies Urban Affairs and Planning For more information, contact the program coordinator, Gloria Schoenholtz schoeng@vt.edu, or the principal investigators, Dr. William Hopkins hopkinsw@vt.edu (P.I.) or Dr. Jeffrey Walters jrwalt@vt.edu (co-P.I.).

SPECIAL FACILITIES

No Facilities

This is a campus wide program and does not have specific facilities

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

MATERIAL CULTURE & PUBLIC HUMANITIES

Brian Britt, Chair

Professors: Brian Britt; Humberto Camilloni; Kevin Concannon; Arthur Ekirch;

Elizabeth Fine; Elizabeth Malbon; Michael Saffle; Bailey Van Hook; Peter Wallenstein;

Associate Professors: Ananda Abeysekara; Marilyn Casto; Matthew Gabriele;

William Green; Kathleen Jones; Brian Katen; Ann-Marie Knoblauch; Michelle Moseley Christian; Anita Puckett; Paul Quigley; Emily Satterwhite; Peter

Schmitthener; Rachel Scott; Daniel Thorp;

Assistant Professors: Aaron Ansell; David Cline; Melanie Kiechle; Madhavi Murty; Zhange Ni; LaDale Winling;

Affiliated Faculty: Deborah Sim;

Graduate Contact: bfine@vt.edu

Graduate Contact: vanhook@vt.edu

Graduate Site: <http://www.rc.vt.edu/matcult/>

This cross-disciplinary degree with two interrelated emphases (material culture and public humanities) shares common intellectual issues and employment goals. Material culture is the study of material or physical objects, as well as the placement of those objects in critical, theoretical and historical perspectives as the products of distinct cultures. Public humanities bridges the divide between academia and the public by encouraging dialogue between scholars and communities on cultural and social issues. This MA degree prepares graduates to interpret material culture and engage communities with humanities issues within informed historical/ cultural frameworks, so that they are prepared for a wide range of careers in museums, historical societies, and community and cultural organizations. The curriculum entails a minimum of 30-credits of graduate courses. Those students who wish also to complete a thesis will take an additional 6 credits, for a total of 36-credits. Those seeking funding through a GA or GTA, applicants should apply by February 15; final application deadline is April 15.

SPECIAL FACILITIES

Students in the MA in Material Culture and Public Humanities can draw upon a variety of facilities, listed below, that will enrich their education.

Armory Gallery

Armory Gallery

Art + Architecture Library

Art + Architecture Library

Center for the Arts

Center for the Arts

Department of History

Department of History

Department of Religion and Culture

Department of Religion and Culture

School of Visual Arts

School of Visual Arts

Special Collections, University Libraries

Special Collections, University Libraries

DEGREES OFFERED

MA Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

General: Verbal (60.0), Quantitative (40.0)

Undergraduate B.S. or B.A. degree in a humanities or design discipline, with preference given to students with degrees in Art History, American Studies, History, Political Science, Communication, History of Design, Classics, Architecture, Landscape Architecture, Religion and Culture, Interior Design, or Industrial Design. Minimum of a 3.5 in-major undergraduate GPA, 3.0 overall undergraduate GPA. Official transcripts, 3 letters of recommendation, and all other documents required by the Graduate School. Degree applicants with work or internship experience

in a related field will be given special consideration.

MULTI-SCALE TRANSPORT IN ENVIRONMENTAL AND PHYSIOLOGICAL SYSTEMS

Professors: John Phillips; Brenda Winkel; Mary Leigh Wolfe;

Associate Professors: Daniela Cimini; Rafael Davalos; Raffaella De Vita; Maria Lazar; Linsey Marr; Shane Ross; David Schmale; Eva Schmelz; John Socha; Mark Stremler; Theresa Thompson; Jianhua Xing; Zhaomin Yang;

General Contact: sallys@vt.edu

MultiSTEPS website: <http://www.multisteps.ictas.vt.edu/>

The goal of MultiSTEPS is to establish a sustainable framework of interdisciplinary education and research at Virginia Tech that trains future leaders of academic and industrial research to think, collaborate, and contribute at the intersection of the biological and engineering sciences. This program will develop participants who are experts in a core discipline of engineering or biology and who are also proficient in the alternate discipline, with understanding and appreciation of its methods, culture, and perspectives. Colleges and Departments: College of Engineering Engineering Science & Mechanics Mechanical Engineering Biological Systems Engineering Civil & Environmental Engineering Electrical & Computer Engineering School of Biomedical Engineering & Sciences Engineering Education College of Science Biological Sciences College of Agricultural and Life Sciences Plant Pathology, Physiology & Weed Science Biological Systems Engineering For more information please contact Mark Stremler, Principal Investigator, stremler@vt.edu

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

NUCLEAR ENGINEERING

Danesh Tafti, Interim Head

Professors: Alireza Haghghat;

Assistant Professors: Celine Hin; Yang Liu; Leigh Winfrey;

Affiliated Faculty: Francine Battaglia; Diana Farkas; Robert Hendricks; Roop Mahajan; Sonja Schmid; Danesh Tafti; James Turso;

Associate Professor of Practice: Mark Pierson;

General Contact: megrad@vt.edu

Mark Pierson: mark.pierson@vt.edu

Graduate Site: <http://www.me.vt.edu>

Bursar's Office - Tuition: <http://www.bursar.vt.edu/>

University Scholarships and Financial Aid: <http://www.finaid.vt.edu/>

Timetable of Classes:

https://banweb.banner.vt.edu/ssb/prod/HZSKVTSC.P_DisRequest

Fellowships and Scholarships:

http://graduateschool.vt.edu/financial/fellowship_scholarship/index.html

Research: <http://www.nuclear.ncr.vt.edu/research.html>

Student Medical Insurance: <http://graduateschool.vt.edu/financial/insurance/>

Dates & Deadlines:

http://graduateschool.vt.edu/academics/dates_deadlines/index.html

New Student Handbook: <http://graduateschool.vt.edu/admitted/index.html>

College of Engineering: <http://www.eng.vt.edu/>

Historical Time Table of Classes:

https://banweb.banner.vt.edu/ssb/prod/HZSKVTSC.P_DisHistorical

Graduate Student Veterans:

http://www.veterans.vt.edu/Graduate_Students/index.html

In response to the growing demand from nuclear industry in Virginia, Virginia Tech restarted its nuclear engineering program (NEP) within the Mechanical Engineering Department, and began again to offer undergraduate and graduate nuclear engineering courses. A graduate Nuclear Engineering Certificate is offered along with the PhD, MS & MEng degrees. NEP draws on expertise and courses from the Mechanical and Materials Science and Engineering Departments in Computational Fluid Dynamics in nuclear materials, and expertise from the Physics Department in neutrino physics and accelerated driven system. Affiliate programs include the School Public and International Affairs (SPIA), and the Department Science and Technology Studies in nuclear policy as well as the College of Veterinarian Medicine for its activities in radiation therapy and diagnostics.

SPECIAL FACILITIES

The reintroduction of the Nuclear Engineering degree program has led to facilities available across the Commonwealth of Virginia, including Arlington and Lynchburg. Interdisciplinary research project crosses several departmental boundaries to provide richer opportunities for graduate students.

Neutron Irradiation Laboratory

The Neutron Irradiation Laboratory is currently under development and expected to be completed in January 2015. It will consist of a neutron generator system, shielding, a pneumatic rabbit transfer system with glovebox, and security and personnel protection safety systems. The

neutron generator system will consist of two MF Thermo Physics P385 neutron generators. Using two neutron generators provides much more flexibility in experiments. They can be synchronized so they pulse at the same time and can be focused on the same target in order to double the neutron exposure up to a maximum of 10^9 neutrons/sec. Each P385 generator can run in pulse mode or continuous mode. Having two generators also allows for running simultaneous experiments with different parameters if needed. Both generators are supplied with a Deuterium-Tritium accelerator head. In addition, a spare Deuterium-Deuterium accelerator head is also available to provide lower neutron energies (2.45 MeV). The lower neutron energies are more comparable to the energy seen in a fission reactor. The neutron irradiation laboratory supports planned and current courses in the areas of radiation detection and measurement, radiation shielding, nuclear nonproliferation and safeguards, and particle transport. In addition, it will support ongoing research activities in the areas of radiation detection and materials, nuclear materials, reactor physics and design, nuclear security and safeguards, nuclear forensics, homeland security, medical physics, and medical isotope production.

Radiation Measurement, Simulation and Visualization Laboratory (RMSVL)

The laboratory supports research activities in radiation detection and materials, radiation dosimetry, light-weight radiation shielding materials, radiation detection arrays, medical physics, nuclear safeguards, design of passive and active interrogation systems, benchmarking of particle transport codes and radiation transport visualization. In addition, it provides modeling, simulation and visualization of the results. Finally, it provides radiation literacy through experiments conducted by students in the various nuclear engineering courses. Equipment included in the lab:

- Reverse electrode Germanium detector, 60% efficiency with hybrid cryostat - Digital spectrum analyzer - NaI and LaBr scintillation detectors
- Various radiation detection instruments and probes - Lead-shielded counting systems - 32 processor computational cluster with large panel displays for visualization

Signature Engineering Building

The Signature Engineering Building will house the Nuclear Engineering offices.

Virginia Tech's Advanced Research Computing

Virginia Tech's Advanced Research Computing: Advanced Research Computing (ARC) at Virginia Tech is an innovative and interdisciplinary environment advancing computational science, engineering and technology. Its mission is to:

- Provide computing and visualization resources, support, and leadership to advance computational research at Virginia Tech.
- Provide partnerships and support for joint faculty appointments in academic departments, building areas of excellence in computational science and engineering across disciplines, and providing opportunities for new innovation in scientific computing.
- Offer

educational programs and training on scientific computing, encouraging the development of knowledge and skills in computational tools and techniques for undergraduate, graduate and research faculty and staff.

- Offer programs to stimulate and expand interdisciplinary and computational driven research activity at VT, including visiting researcher, travel, distinguished postdoctoral fellow and graduate student programs that provide new sources of support for collaboration, research, and development.
- Affiliate with business, industry, and government to help drive economic development growth in Virginia by building connections between research and applications for emerging tools and techniques in computational science and engineering.
- Collaborate with other computational science and engineering driven research centers in advancing knowledge and leading the evolution of scientific computing tools, techniques, and facilities that accelerate scientific discovery.

Visionarium for virtual 3-D visualization

Visionarium for virtual 3-D visualization: Built in June 2010, the VisBox VisCube(TM) is the replacement to the old CAVE. Like the CAVE before it, the VisCube has three rear-projected ten foot square walls and a top-projected floor with a cutout hiding a MOOG motion platform. The VisCube features numerous hardware and software upgrades to increase the fidelity of the visualization (more pixels (1920x1920 per wall!), more brightness, more contrast) as well as the ease of use for the researcher (wireless tracking).

DEGREES OFFERED

MS Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Blacksburg, Richmond)

TOEFL

Paper: (620.0)

iBT: (105.0)

TOEFL Computer Based

Computer Based: CBT (260.0)

GRE

General: Verbal (150.0), Quantitative (155.0), Analytical (4.5)

Please contact megrad@vt.edu for specific location information. Acceptance into the VT Nuclear Engineering graduate program is based on the overall application package. In general, the minimum target requirements are to the left. The application materials required can be accessed from the application instructions web page. Master of Science (MS) Degree Requirements

Earning an MS degree requires completing a 30-credit-hour program subject to the following requirements. Except as indicated, courses must be taken for a grade, not Pass/Fail. MS students must submit a Plan of Study before completing the first semester registered as a MS student. No grade below B is allowed for any core course.

1. Master of Science Courses: A minimum of 21 graded credit-hours of courses must be taken including the following:

- a. Core Courses (15 graded credit-hours) which include four required courses

and one mathematics/statistics course: 12 credit-hours of required courses: (1) NSEG 5124 Nuclear Reactor Analysis(2) NSEG 5204 Nuclear Fuel Cycle(3) NSEG 5604 Radiation Detection and Shielding (4) either NSEG 5424 Reactor Thermal Hydraulics or MSE 5384G Advanced Nuclear MaterialsA minimum of 3 graded credit-hours of a mathematics or statistics course from an approved list of courses. b. Elective Courses: Six credit-hours of any science, engineering or mathematics 5000-level, or higher, courses as approved by the Advisory Committee are required. However, if only six credit-hours of NSEG 5994 are applied toward the degree instead of nine credit-hours (see Research Requirements below), the student must take an additional 3 credits of any science, engineering or mathematics 5000-level, or higher course, as approved by their Advisor, to satisfy the requirement for a total of 30 credit-hours for the M.S. degree.The graded course work may include 5984/6984 Special Study. However, a student cannot exceed a maximum of 6 credit hours of 5974, 5984, and 6984. 2. Master of Science Research Requirement: A minimum of 6 credit-hours of NSEG 5994 Research and Thesis, not to exceed 9 credit-hours, must be completed. Additional Requirements: All students must satisfactorily pass an oral final examination, write and successfully defend a thesis. Seminar Program: All students must participate in the nuclear engineering program seminar series.Ethics: Beginning Fall 2014, all graduate students must meet the Graduate School's Ethics requirement. Course work From Another Institution (MS and MEng): Per the Graduate School, not more than 50% of required graded course work from another institution may be transferred. All transferred course credits must have the grade of "B" or higher and must have been earned while enrolled as a graduate student. Transfer work is evaluated/approved when the Plan of Study is submitted. All transfer credits must be accompanied by transcripts which verify grades. Course descriptions are also required. Transfer courses on the Plan of Study must be approved by the student's Advisory Committee.It is anticipated that students will complete the MS program in two years following undergraduate studies in a nuclear-related field, or with a minor in a nuclear-related field. If a student already has a B.S. in Nuclear Engineering, they are expected to complete the MS program in less time, perhaps in as few as three semesters.No courses below the 5000-level will be accepted for graduate credit.

MEng Degree

Offered In (National Capital Region, Southwest Virginia, Hampton Roads, Blacksburg, Richmond)

TOEFL

Paper: (620.0)

iBT: (105.0)

GRE

General: Verbal (150.0), Quantitative (155.0), Analytical (4.5)

TOEFL Computer Based Test

CBT Score: CBT Score (260.0)

Please contact megrad@vt.edu for specific location information. Acceptance into the VT Nuclear Engineering graduate program is based on the overall application package. In general, the minimum target requirements are to the left. The application materials required can be accessed from the application instructions web page.Master of Engineering (MEng) Degree RequirementsEarning an MEng degree requires completing a 30-credit-hour program subject to the following requirements. Except as indicated, courses must be taken for a grade, not Pass/Fail. MEng students must submit a Plan of Study before

completing the first semester registered as a MEng student. No grade below B is allowed for any core course. 1. Master of Engineering Courses: A minimum of 24 graded credit-hours of courses must be taken including the following:a. Core Courses (15 graded credit-hours) which include four required courses and one mathematics/statistics course: 12 credit-hours of required courses: (1) NSEG 5124 Nuclear Reactor Analysis(2) NSEG 5204 Nuclear Fuel Cycle(3) NSEG 5604 Radiation Detection and Shielding (4) either NSEG 5424 Reactor Thermal Hydraulics or MSE 5384G Advanced Nuclear MaterialsA minimum of 3 graded credit-hours of a mathematics or statistics course from an approved list of courses. b. Additional NSEG Course: An additional 3 credit-hours of a graded NSEG 5000-level, or higher, course is required.c. Elective Courses: Three credit-hours of any science, engineering or mathematics 5000-level, or higher, course as approved by the Advisory Committee are required. However, if only three credit-hours of NSEG 5904 are applied toward the degree instead of six credit-hours (see Project Requirements below), the student must take an additional 3 credits of any science, engineering or mathematics 5000-level, or higher course, as approved by their Advisor, to satisfy the requirement for a total of 30 credit-hours for the M.Eng. degree.The graded course work may include 5984/6984 Special Study. However, a student cannot exceed a maximum of 6 credit hours of 5974, 5984, and 6984. 2. Master of Engineering Project Requirement: A minimum of 3 credit-hours of NSEG 5904 Project and Report, not to exceed 6 credit-hours, must be completed. Additional Requirements: All students must satisfactorily pass an oral final examination, write and successfully defend a Project & Report.Seminar Program: All students must participate in the nuclear engineering program seminar series.Ethics: Beginning Fall 2014, all graduate students must meet the Graduate School's Ethics requirement.Course work From Another Institution (MS and MEng): Per the Graduate School, not more than 50% of required graded course work from another institution may be transferred. All transferred course credits must have the grade of "B" or higher and must have been earned while enrolled as a graduate student. Transfer work is evaluated/approved when the Plan of Study is submitted. All transfer credits must be accompanied by transcripts which verify grades. Course descriptions are also required. Transfer courses on the Plan of Study must be approved by the student's Advisory Committee.It is anticipated that students would be able to complete the MEng program in two years following undergraduate studies in a nuclear-related field, or with a minor in a nuclear-related field. If a student already has a B.S. in Nuclear Engineering, they are expected to complete the MEng program in less time, perhaps in as few as three semesters.No courses below the 5000-level will be accepted for graduate credit.

PhD Degree

Offered In (National Capital Region, Southwest Virginia, Blacksburg)

TOEFL

Paper: (620.0)

iBT: (105.0)

GRE

General: Verbal (150.0), Quantitative (155.0), Analytical (4.5)

Computer Based TOEFL

CBT Score: CBT Score (260.0)

A Ph.D student has a deeper knowledge of the nuclear engineering subject matter than a Master's student and, upon graduation, would be expected to be able to carry out a comprehensive research project. Earning a Ph.D. requires the completion of a 90-credit-hour program (including the courses taken for a Master's degree) subject to the

following requirements. Except as indicated, courses must be taken for a grade—not Pass/ Fail. No grade below B is allowed for any core course.

Doctor of Philosophy (PhD) Degree Requirements The 90 credit-hours are made up of (1) 30 graded credit-hours of coursework consisting of six core courses and four additional courses in the categories of NSEG 6000-level courses, Breadth or Elective courses, (2) 30 credit-hours of research, and (3) 30 credit-hours of enhancement courses which may consist of either research credits or graduate-level courses taken from any unit of the University.

1. Doctor of Philosophy Courses: A minimum of 30 graded credit-hours of courses must be taken including the following:

a. **Core Courses (18 graded credit-hours)** which include four required courses and two mathematics/statistics courses: 12 credit-hours of required courses: (1) NSEG 5124 Nuclear Reactor Analysis (2) NSEG 5204 Nuclear Fuel Cycle (3) NSEG 5604 Radiation Detection and Shielding (4) either NSEG 5424 Reactor Thermal Hydraulics or MSE 5384G Advanced Nuclear Materials A minimum of 6 graded credit-hours of a mathematics or statistics courses from an approved list of courses.

b. **6000-level NSEG Courses:** Any two NSEG 6000-level courses as approved by the Advisory Committee.

c. **Breadth Requirement:** An additional 3 credit-hour NSEG 5000-level, or higher, graded course. This course should provide some breadth by being in an area outside the student's specialization as determined by the student's Advisory Committee.

d. **Elective Course:** Three credit-hours of any science, engineering or mathematics 5000-level, or higher, course as approved by the Advisory Committee is required. The graded course work may include 5984/6984 Special Study. However, a student cannot exceed a maximum of 12 credit hours of 5974, 5984, and 6984.

2. Doctor of Philosophy Research Requirement: A minimum of 30 credit hours of NSEG 7994 Research & Dissertation must be completed successfully.

3. Doctor of Philosophy Enhancement Requirement: A minimum of 30 additional credit-hours consisting of a combination of either graduate coursework (5000-level or higher) from any unit of the University and/or research and dissertation credits (NSEG 7994), as approved by the student's Advisory Committee. These credits are tailored for the specific research topic and background of the student. Additional in-depth courses related to the student's research area, if applicable, would be included under this requirement. Moreover, students who plan to enter academia after completion of their PhD are encouraged to take electives such as GRAD 5104 Preparing the Future Professoriate and ENGE 5014 Foundations of Engineering Education. Those planning to enter industry are encouraged to take electives such as GRAD 5314 Future Industrial Professional in Science and Engineering. Obtaining a Graduate Certificate in the Future Professoriate or other areas are also encouraged. These electives will also satisfy part of the 30 credit-hours enhancement requirement.

Additional Requirements: All students must satisfactorily pass the qualifying, preliminary and oral final examinations, write and successfully defend a dissertation, and complete a residency experience through full-time enrollment on the Virginia Tech Blacksburg or NOVA campus for two consecutive semesters.

Seminar Program: All students must participate in the nuclear engineering program seminar series.

Ethics: Beginning Fall 2014, all graduate students must meet the Graduate School's Ethics requirement.

Course work From Another Institution: Per the Graduate School, not more than 50% of required graded course work from another institution may be transferred. All transferred course credits must have the grade of "B" or higher and must have been earned while enrolled as a graduate student. Transfer work is evaluated/approved when the Plan of Study is submitted. All transfer credits must be accompanied by transcripts which verify grades. Course descriptions are also required. Transfer courses on the Plan of Study must be approved by the student's Advisory Committee. No courses below the 5000 level will be accepted for graduate credit toward the Doctor of Philosophy in Nuclear Engineering.

GRADUATE COURSES (NSEG)

NSEG 5114:

Nuclear Eng Fundamentals

A foundation course in nuclear engineering. Neutron physics, reactor theory and kinetics, basic reactor design and operation, and overall power plant operation. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NSEG 5124:

Nuclear Reactor Analysis

Nuclear reactions and fission process. The fission chain reaction. Neutron diffusion and moderation. One-speed diffusion model of a nuclear reactor. Neutron slowing and multigroup diffusion theory. Nuclear reactor kinetics. Introduction to reactor core physics design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): NSEG 5114

Corequisite(s):

NSEG 5134:

Monte Carlo Particle Transport

Basic particle transport concepts. Random processes, random number generation techniques, fundamental formulation of Monte Carlo, sampling procedures, and fundamentals of probability and statistics. Monte Carlo algorithms for particle transport, non-analog Monte Carlo method, formulations for different variance reduction techniques, and tallying procedures. Methodologies for parallelization and vectorization of the Monte Carlo methods, and examples of the Monte Carlo method for simulation of various real-life applications. Graduate standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

Nuclear Fuel Cycle

Uranium nuclear fuel cycle: 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 the cycle. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NSEG 5214:

Nuclear Plant Systems & Ops

Pressurized and boiling water reactors, detailed system functions and operation, reactor plant startup and shutdown procedures, reactor trip and casualty procedures, reactor transient response analysis, reactor plant licensing, ethics and integrity in the nuclear industry.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): NSEG 5114

Corequisite(s):

NSEG 5424:

Reactor Thermal Hydraulics

Fundamental processes of heat generation and transport in nuclear reactors. Heat generation by fission and radiation interactions; spatial distribution of heat generation; heat transport by conduction and convection. Effects of boiling and critical heat flux. Fundamentals of reactor thermal and hydraulic design.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s): NSEG 5114

Corequisite(s):

NSEG 5604:

Radiation Detect & Shielding

Radioactive decay, interaction of charged particles and photons with matter, methods of radiation detection and radiation dosimetry, counting statistics, external radiation protection using time, distance and shielding. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NSEG 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

NSEG 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

NSEG 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NSEG 5994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

NSEG 6124:

Adv Nuclear Reactor Analysis

Neutron transport theory. Neutron slowing down and resonance

absorption. Neutron thermalization. Perturbation and variational methods. Homogenization theory. Space-time neutron kinetics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): NSEG 5124 (UG)

Corequisite(s):

NSEG 6334:

Nuclear Reactor Safety

Hazards of nuclear reactors; analysis of hypothetical design basis accidents; engineered safeguards and safety design principles; nuclear criticality safety; reactor containment; reactor safety codes; and probabilistic risk assessment.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s): NSEG 5114

Corequisite(s):

NSEG 6984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 10

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

NSEG 7994:

Research and Thesis

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PUBLIC HEALTH

Francois Elvinger, Head

Professors: Francois Elvinger; Stephen Eubank; Jennifer Hodgson; Frank Pierson; Kerry Redican;

Associate Professors: Kathryn Hosig;

Assistant Professors: Kaja Abbas; Andrea Bertke; Brandy Burgess;

Associate Professor of Practice: Susan Marmagas;

Graduate Contact: phs@vt.edu

Graduate Site: <http://www.mph.vetmed.vt.edu>

Virginia Tech's Department of Population Health Sciences in the Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM) in partnership with the Virginia Tech Carilion School of Medicine (VTCSOM) has implemented a Public Health Program designed to provide students the requisite advanced skills and expertise necessary to join the public health workforce with a Master of Public Health degree. The integration and expansion of public health offerings at Virginia Tech and VTCSOM will contribute to the improvement of health in communities of Southwest and Southside Virginia, the Commonwealth, the Appalachian Region, the United States, and beyond. The Master of Public Health degree program provides professional preparation in the core competencies, functions, and responsibilities of public health. The program offers flexible plans of study to address the needs of students pursuing complementary degrees and those who are already in the workforce as practicing professionals. Program faculty and students conduct public health research in partnership with health agencies throughout the region and beyond. Research efforts are directed at social and ecological determinants of health, reducing social inequalities in health, and building healthy communities.

SPECIAL FACILITIES

DEGREES OFFERED

MPH Degree

Offered In (Blacksburg)

GRE

The Master of Public Health degree program is a 42-credit professional program grounded in a set of competencies in five core discipline areas (Biostatistics, Environmental Health, Epidemiology, Health Administration, and Health Behavior) as well as a set of professional interdisciplinary cross-cutting competency domains. Required core courses are: PHS 5004: Fundamentals of Public Health STAT 5674: Methods in Biostatistics PHS 5014: Environmental Health PHS 5024: Epidemiology PHS 5034: Health Behavior and Health Education PHS 5044: Public Health Administration PHS 5914: Practicum in Public Health PHS 5924: Capstone in Public Health Admissions For information on admissions requirements, please visit our website or contact us at phs@vt.edu or 540-231-3945.

Degree Concentrations:

Public Health Education

PHS 5204: Principles of Community Health Education PHS 5214:

Program Development in Health Education PHS 5984 SS: Public Health Program Evaluation

Infectious Disease

PHS 5984 SS: Principles of Infectious Diseases PHS 5304: Zoonoses and Infectious Diseases Common to Humans and Animals PHS 5314: Infectious Disease Epidemiology

GRADUATE COURSES (PHS)

PHS 5004:

Fundamentals Public Health

Theory, concepts, and practices related to public health; five major topics of public health including health services, epidemiology, social behavioral science, public and environmental health and biostatistics; special emphasis placed on history of public health, biomedical basis for public health intervention, public health ethics.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5014:

Environmental Health

Exploration of major environmental health concepts and issues, environmental policies and regulations. Topics include world population and pressures on the environment, healthy environment; environmental determinants of public health, including biological, physical and chemical factors; disease vectors and their control; air and water quality; waste management; the built environment, work environments and recreational area; food protection and safety; occupational health; tools for environmental evaluation, planning and safety. Pre: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5024 (HNFE 5724):

Epidemiology

Epidemiology is the study of the distribution and determinants of the varying rates of diseases, injuries, or other health states in human and animal populations. This course consists of an introduction to epidemiological terminology, concepts and research methodology.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5034:

Health Behavior and Health Education

This course has two main purposes: (1) to familiarize students with historical, theoretical and methodological aspects of health psychology, and (2) to acquaint health education students with the social, psychological, and cultural determinants of health behaviors which form the underpinnings of health education practice.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5044 (HNFE 5694):

Public Health Administration

This course will focus on relevant and timely public health administration concepts. The major topics covered include health policy, health care planning, health care economics, health law, and managerial functions as they relate to health care and public health settings.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5204:

Principles of Community Health Education

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5214 (HNFE 5684):

Program Development in Health Education

Theory, trends, and design of community health education programs implemented in communities, health agencies, hospitals, and industry.

Pre: Graduate standing.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5224:

Comp Health Systems

Comprehensive examination of the structure and function of worldwide healthcare and public health systems. National health services with central funding, social insurance programs, decentralized systems, and private insurance systems. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5304:

Zoonoses and Infectious Diseases Common to Humans and Animals

Epidemiology of bacterioses, mycoses, chlamydioses, rickettsioses, parasitosis, viroses and prion diseases that are transmissible between animals and humans and/or are acquired by animals and human from the same source and that have great impact on public health. Cultural, social and economic factors and impacts; modes of inter - and intra- species transmission including roles of vectors and environmental factors; concepts of emergence and re-emergence; pathogenesis in various hosts and host adaptation; temporal and spatial dynamics and risk factors for exposure, infection and expression of clinical disease; modes of detection, control/mitigation and prevention; biosecurity, including food safety and security. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5314:

Infectious Disease Epidemiology

Dynamics and determinants of infectious diseases and their assessment on the molecular to population continuum in a systems based approach. Infectious disease transmission mechanisms; population susceptibilities;

environmental, social, cultural and economic contributors to infectious disease propagation; detection and surveillance; geographic information systems; epidemiologic study design; and infectious disease modeling.

Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5324:

Pub Hlth Infect Contrl & Prev

Assessment, policies, and procedures for control and prevention of infectious diseases in communities and populations. Sources, transmission mode, and local community to international dissemination of infectious disease agents; antimicrobial and chemical resistance; vaccine development, safety, and coverage; community and hospital based needs and interventions; and regulatory frameworks. Pre-requisite: Graduate Standing required.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5704:

Educational Technology in Public Health

Role of technological concepts in the development, implementation, and evaluation of public health and health promotion programs; emphasis on sound principles of educational design, digital media application, development of podcasts, development of web pages, and technology use in e-learning and all facets of public education and promotion. Pre-requisite: Graduate Standing required

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5714:

Health of the Elderly

The health needs and problems of the elderly, the implications for those working with the elderly, and possible health care delivery systems.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

PHS 5904:

Project and Report

Credit Hour(s): 1 TO 19

Lecture Hour(s):

Instruction Type(s): Research

Instruction Type(s): Research

Prerequisite(s):

Corequisite(s):

PHS 5914:

Practicum in Public Health

Public health theories and concepts in a work setting; comprehensive, structures experience requires student to demonstrate professional competencies while working closely with a supervisor in a public health practice setting. Pre-requisite: Graduate Standing and completion of 24 hours of MPH degree coursework.

Credit Hour(s): 6

Lecture Hour(s): 6

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5924:

Capstone in Public Health

Synthesis of coursework and practicum experience into a final comprehensive product which integrates knowledge and skills acquired in all core classes, specific MPH concentration courses and practicum experience for developing, implementing and evaluating a public health program; tests student's ability to effectively analyze a public health problem and develop an intervention toward a solution to the problem. Pre-requisite: Graduate standing; completion of 39 hours of MPH coursework including enrollment in or completion of public health practicum.

Credit Hour(s): 3

Lecture Hour(s): 3

Instruction Type(s): Lecture

Instruction Type(s): Lecture

Prerequisite(s):

Corequisite(s):

PHS 5974:

Independent Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Independent Study

Instruction Type(s): Independent Study

Prerequisite(s):

Corequisite(s):

PHS 5984:

Special Study

Credit Hour(s): 1 TO 19

Lecture Hour(s): 1 TO 19

Instruction Type(s): Lecture, Online Lecture

Instruction Type(s): Lecture, Online Lecture

Prerequisite(s):

Corequisite(s):

REGENERATIVE MEDICINE

Williard Eyestone: weyest@vt.edu

Regenerative medicine (RM) is a new medical approach that seeks to restore both structure and function of tissues lost to injury, disease or congenital defects. This field incorporates use of stem cells, proteins that stimulate healing, and engineered biomaterials to help cure diseases from diabetes to osteoarthritis. Regenerative strategies are modeled on mechanisms drawn from embryonic development and naturally-occurring examples of regeneration. This field represents a paradigm shift in biology, medicine and biomedical engineering. Ethical and societal impacts need to be considered as this rapidly expanding technology is developed. Furthermore, the swift translation of these technologies to the clinical realm provokes a need for both public policy considerations and practical feasibility from a business perspective. Leaders in RM must have training, understanding and interactions across diverse disciplines. The Regenerative Medicine Interdisciplinary Graduate Education Program (IGEP) team aims to produce leaders in RM by training students in the broad complexities inherent to the field, beyond expertise gained in their specific disciplines. The IGEP will be among the first programs of its kind to equip students with a broad-based, graduate-level education in the field of RM. Colleges and Departments: College of Veterinary Medicine Biomedical Sciences and Pathobiology Large Animal Clinical Sciences Small Animal Clinical Sciences College of Engineering Materials Science and Engineering Chemical Engineering Engineering Science and Mechanics Biomedical Engineering and Sciences College of Liberal Arts and Human Sciences Science and Technology in Society College of Business Marketing Management For more information please contact: Williard Eyestone, Principal Investigator, weyest@vt.edu

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

REMOTE SENSING

Randolph Wynne: wynne@vt.edu

Wayne Scales: wscscales@vt.edu

Currently, there is no university in the nation that offers an advanced degree in remote sensing that covers the entire spectrum of skills required in the field: from technical know-how and hands-on instrument design experience; to detailed theoretical insight into the underlying physical processes; to cutting edge image processing and data analysis/retrieval skills; to top level applications of remote sensing data and their policy implications. We are at a critical juncture with faculty expertise and collaborative interests that would enable, through an Interdisciplinary Graduate Education Program (IGEP), the development of a fully integrated educational experience that would strengthen and enhance the ability of our graduates to address the interdisciplinary challenges facing remote sensing scientists in today's workplace. Our proposed program at Virginia Tech will meet the existing need by providing a balanced experience for students spanning the domains of engineering, theory, data analysis, applications, and policy. Colleges and Departments: College of Engineering Computer Science Electrical and Computer Engineering College of Science Statistics College of Natural Resources and Environment Forest Resources and Environmental Conservation Geography College of Liberal Arts and Human Sciences History and Science and Technology Studies For more information please contact: Randolph Wynne, wynne@vt.edu or Wayne Scales, wscscales@vt.edu, Co-Principal Investigators

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

SUSTAINABLE NANOTECHNOLOGY

Peter Vikesland: [pvikes@vt.edu](mailto:pviks@vt.edu)

The focus of the SuN IGEP is to develop a new paradigm wherein the sustainability of a given nanotechnology is considered during its entire life cycle. The primary research goal of the SuN IGEP is to facilitate the incorporation of sustainable design concepts in the nanotechnology field.

The sustainability of a particular technology is often an afterthought in the design process; however, because nanotechnology is still in its infancy there is significant potential to proactively direct the field towards sustainable design. The primary educational goal of the SuN IGEP is to produce doctoral graduates that have the skills and expertise to provide leadership in the interdisciplinary field of sustainable nanotechnologies. This IGEP builds upon the existing infrastructure of the ICTAS VTSuN Center of Excellence, the NSF/EPA supported Center for the Environmental Implications of Nanotechnology (CEINT), and the EIGER NSF IGERT and the Green Engineering programs at Virginia Tech. Collectively these interdisciplinary efforts provide the intellectual focus and background for our IGEP group. Colleges and Departments: College of Engineering Civil and Environmental Engineering Materials Science and Engineering College of Natural Resources and Environment Wood Science and Forest Products College of Science Departments Geosciences For more information please contact Peter Vikesland, Principal Investigator, pvikes@vt.edu

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

TRANSLATIONAL BIOLOGY, MEDICINE, AND HEALTH

Graduate Contact: mdietric@vt.edu

Graduate Site: <http://www.tbmh.vt.edu/>

The TBMH program has been designed to help address a national need for accelerating the pace of translation of biomedical discoveries into diagnostics, treatments, and cures, as well as their effective implementation. Major national organizations, such as the National

Institutes of Health, Association of American Medical Colleges, and the Federation of American Societies for Experimental Biology, have called for new approaches to train biomedical and health scientists to achieve this goal, recognizing that today's researchers must utilize interdisciplinary approaches, communicate across levels of inquiry, and be prepared for the diverse careers that drive today's biomedical research enterprise. Graduates of the TBMH program will be well prepared to take on these challenges and become tomorrow's scientific leaders. Through a combination of TBMH core and focus area-specific coursework, students will be trained to go deep at advanced levels in a particular area (just as in classic disciplines), but also to have the skills, confidence and intellectual breadth to identify today's pressing health issues, and develop them in the framework and context of greater needs. This includes recognizing the likelihood of the adoption and application of translational discoveries, their cost, delivery, and related policy issues. Students may specialize in one of six focus areas: Cancer Development, Aging, and Repair Health Implementation Science Immunity and Infectious Disease Metabolic and Cardiovascular Science Neuroscience Regardless of the focus area in which the students specialize, all graduates of the TBMH program will be able to: Explain the stages of the translational research spectrum Evaluate how multiple complex cellular and molecular factors influence physiological systems Integrate and model the processes of healthful function across scales, from the molecular to the organismal, and the individual to the social network Evaluate and compare published claims for the capacity to prevent or alter trajectories of unhealthy biological processes through genetic, pharmacological, behavioral and health systems interventions Conceive new conceptual approaches or technological strategies for the identification and quantification of pathological processes, their prevention or treatment, and/or the effective implementation of such interventions. Demonstrate effective written and oral communication of scientific concepts and data in translational biology, medical and health research. Work collaboratively in an interdisciplinary environment, which may include basic scientists, translational scientists, clinicians, administrators, or policy makers. Identify career opportunities for biomedical and translational scientists, and conduct one's chosen professional activities in a responsible and ethical manner

SPECIAL FACILITIES

According to the National Science Foundation annual survey of over 900 institutions, Virginia Tech continues to rank in the top 5 percent of colleges and universities in research and development expenditures. The university received almost \$300 million in grant awards in FY2012, and over \$450 million in research expenditures over that same year. Virginia Tech is ideally positioned to train the next generation of translational scientists to fulfill the innovative, interdisciplinary, and collaborative research needs of the future, as it merges strengths in the life sciences, social sciences, bioinformatics, and engineering, with an expanding biomedical and health research enterprise. This includes a recent \$150 million investment in the Virginia Tech Carilion School of Medicine and Research Institute, located in Roanoke, Virginia. Due to the interdisciplinary nature of the program and the diversity of the faculty mentors and instructors (including clinical faculty who will instruct in courses and participate in student thesis advisory committees), students will have access to a broad range of Virginia Tech's research and instructional facilities located in both Blacksburg and Roanoke. Participating colleges include: College of Agriculture and Life Sciences College of Engineering, including the Virginia Tech Wake Forest University School of Biomedical Engineering and Sciences College of Liberal Arts and Human Sciences College of Natural Resources and Environment College of Science College of Veterinary Medicine Virginia Tech Carilion School of Medicine Students have the opportunity to

participate in research rotations with three different research groups before selecting a thesis mentor, and may select from participating faculty at Virginia Tech's facilities in Blacksburg or Roanoke. The two campuses are conveniently interconnected through a free university shuttle system with onboard wireless internet, as well as via the Smart Way Commuter Bus. Both locations also utilize state of the art interactive videoconferencing technology to assist with multi-site course instruction and student thesis committee meetings, as well as for transmitting visiting guest lectures and seminar series between campuses.

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

GRE

TOEFL

Paper: (550.0)

iBT: (80.0)

Students pursuing a TBMH Ph.D. degree must earn a minimum of 100 credit hours beyond the baccalaureate, including 31 credits of core coursework, 6 credits of elective coursework, and 63 credits of research and dissertation. An M.S. degree is not required for admission to the program, though students with an M.S. are also eligible to apply. All coursework must be 5000-level and above. Students perform three research rotations before selecting a thesis mentor at the end of the second semester of study. Students must select one of the program's "Focus Areas" by the end of the first semester. Candidates are eligible for graduation upon successful completion of all core, elective, and research credits, as well as passing performance on the Qualifying Examination, Preliminary Examination (advancement to candidacy), and successful oral defense of a written dissertation. Course Requirements: All students will be required to take the following core classes (31 credits): TBMH 5004 Translational Biology, Medicine, and Health (8 credits) TBMH 50X4 Fundamentals in [Focus Area] (8 credits) TBMH 5105 Professional Development and Ethics (2 credits) TBMH 5106 Professional Development and Ethics (2 credits) TBMH 5304 Research Experience in TBMH (2 x 3 credits = 6 credits) TBMH 5204 Seminar in Translational Biology, Medicine and Health (4 x 1 credits = 4 credits) TBMH 5404 Scientific Logic and Analysis (1 credit) In addition, students must take the following: Quantitative Elective (3 credits) Free Elective (3 credits) TBMH 7994 Research and Dissertation (63 credits)

Degree Concentrations:

Cancer

Students entering this focus area will have an interest in eliminating the suffering and death due to cancer, through research in cancer prevention, early diagnosis, and treatment interventions. Focus area-specific coursework will take an integrative, translational approach to all aspects of neoplastic disease, from its basis in molecular cell biology (including genetics, stem cells, invasion and metastasis, immune surveillance) to its diagnosis and treatment (biomarkers, drug design, screening, personalized medicine, surgical approaches), as well as its social, psychological, and economic consequences. Students will develop a solid foundation for pursuing interdisciplinary doctoral level

research in cancer biology.

Development, Aging, and Repair

Students entering this focus area will have an interest in promoting a better quality of life through research into the biomedical and behavioral components of development and aging, as well as cutting edge technologies and methodologies for improving health in cases of developmental or age-related disorders and injuries. This focus area will emphasize processes critical to human biology and well-being across the lifespan. Students will develop a strong understanding of critical genetic, cellular, molecular, physiological, environmental and psychological aspects of human development, and how these processes go awry with aging, in order to best address how to repair them.

Students will learn about multiple systems and techniques (including regenerative medicine). Faculty from diverse departments will come together to instruct students on the biological, psychological, social, and public policy components of the development and aging populations, as well as state of the art reparative approaches. Graduates will be well prepared to carry out innovative, interdisciplinary research to address critical challenges facing our developing and aging populations.

Health Implementation Science

Health Implementation Science is an emerging field strongly endorsed by the National Institutes of Health, The Institute of Medicine, and The National Research Council. It is located at far end of the clinical translational continuum -- focused on scientific inquiry about the “uptake” of major medical and health discoveries by practitioners and policymakers and their impact on the well-being of individuals and communities. Historically, the lag time from discovery of a major efficacious treatment to its actual clinical implementation has been estimated as 17 years, and many highly efficacious, affordable treatments are being implemented improperly, incompletely, and/or inequitably, thus failing to realize the benefits anticipated. Above all, there is grave concern that the mega-investments in basic science and clinical research are not yielding their full impact. In a now-seminal New England Journal of Medicine article, Zerhouni (2005), then Director of the National Institutes of Health, called for corrective action by creating “a new, vital, and reinforced academic discipline and home for translational and clinical science — along with an explicit effort to maximize the effectiveness of NIH resources directed to this area of research — to ensure that extraordinary scientific advances of the past decade will be rapidly captured, translated, and disseminated for the benefit of all Americans.” Students in the Health Implementation Science focus area will learn the basic terminology and approaches from a range of specialty fields -- including health literacy, information dissemination, health systems research, public health, community-based participatory research, health economics, and health disparities research – and explicitly connect them to conduct implementation science. Students will engage in case studies from all of the major basic biology, medicine, and

health fields to understand the pathway from discovery of efficacious treatments or preventive interventions to their extension to clinical practice and the measurement of patient-oriented outcomes.

Immunity and Infectious Disease

Students entering this focus area will have an interest in performing research towards the understanding, prevention, and treatment of infectious and immunologic diseases. Track-specific coursework will take an integrative, translational approach to all aspects of infectious disease. They will learn about and discuss contemporary and emerging pathogens (viral, bacterial, and other), the human immune response, the development and delivery of novel diagnostics and therapeutics, as well as the social, psychological, and economic consequences of infectious and immune diseases. Students will develop a professional level of expertise in immunity and infectious disease, and learn to apply this knowledge to carry out innovative and interdisciplinary research to advance disease prevention, diagnostics and treatment.

Metabolic and Cardiovascular Science

Students entering this focus area will have an interest in improving health and quality of life through research on cardiovascular and metabolic health. Students will develop a comprehensive understanding of metabolic and cardiovascular physiology, and their interrelationship. This will include topics such as principle energy systems, appetite and energy expenditure, and cardiovascular function and regulation. Similar to other focus areas in the program, they will perform extensive analysis of primary literature and case studies covering the epidemiology, pathophysiology, and socioeconomic impact of cardiometabolic diseases (such as diabetes, obesity, and heart disease) with an emphasis on the translation of basic scientific discoveries into practical applications.

Neuroscience

Students entering this focus area will have an interest in reducing the burden of neurological and mental health disorders through research. Students will develop an understanding of the normal biological processes that undergird healthy brain and cognitive function, the causes and mechanisms of dysregulation that lead to dysfunction, and current and evolving approaches to therapy and novel therapeutic development. They will explore the inter-relationships of these processes at multiple levels at the intersection of brain biology, behavior, cognition, medicine and health and develop a strong foundation for pursuing doctoral level research in the brain and cognitive sciences.

TRANSLATIONAL OBESITY RESEARCH

Kevin Davy: kdavy@vt.edu

Paul Estabrooks: estabrkp@vt.edu

Obesity is one of the most complex public health problems facing the nation and world today. More than a third of Americans and over one billion people worldwide are obese. Significant progress has been made in basic science discoveries related to the regulation of energy balance and in identifying efficacious lifestyle and pharmacologic approaches to manage obesity under tightly controlled conditions in primarily academic healthcare settings. However, there is little information available regarding the clinical relevance of many basic science discoveries or in the translation of promising clinical interventions to evidenced-based practice. Furthermore, little progress has been made in implementing and disseminating effective obesity prevention and treatment programs on a broad scale to have a positive public health impact. Thus, innovative interdisciplinary graduate training programs are needed to equip the next generation of scientists with the skills and knowledge needed to tackle the complex societal problem of obesity. This Translational Obesity Research graduate training program organized through the Interdisciplinary Graduate Education Program (IGEP) will draw faculty and students from diverse disciplines together to form integrative research teams with a central focus on translational obesity research, spanning from "cells to society" (i.e., from basic science to practice, policy and practice implementation). Colleges and Departments: College of Agriculture and Life Science Human Nutrition, foods and Exercise Agricultural and Applied Economics College of Liberal Arts and Human Sciences Human Development Communications College of Science Psychology For more information please contact: Kevin Davy, kday@vt.edu or Paul Estabrooks, estabrpk@vt.edu, Co-Principal Investigators

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

TRANSLATIONAL PLANT SCIENCE

John McDowell: johnmcd@vt.edu

Translational Plant Science (TPS) is the process through which knowledge from basic research on plant genetics and genomics is used to improve agricultural productivity. The central goals of the TPS program are to (1) create a new training model to prepare molecular plant scientists to function along the bench-to-marketplace pipeline. (2) catalyze interdisciplinary research to address challenges in food security, plants as biofactories, and biomass. The foundation for this project is our existing Molecular Plant Science doctoral program (MPS) that spans seven departments and three colleges. This program is now robust in its capacity to attract strong students and develop in them a deep knowledge of molecular plant science. However, our program, like

many similar programs in the US, does not provide formal training to develop the mindsets and skills students need to link basic plant science with downstream applications. The TPS program is designed to develop these mindsets and skills, which include: a global perspective on the challenges and opportunities presented by plant diseases; the ability to frame novel, use-inspired research questions and to pursue the answers within interdisciplinary teams; an awareness of the social and economic impacts of agricultural biotechnologies and plant disease and ability to engage the public in meaningful dialog about these complex issues; the ability to function effectively in the diverse cultures of the professions outside of academia that play key roles in the translational plant science pipeline (e.g., business, regulation, policy). Colleges and Departments: College of Engineering Aerospace Engineering College of Agriculture and Life Sciences Agricultural and Applied Economics Biochemistry Biological Systems Engineering Crop, Soil, and Environmental Science Horticulture Plant Pathology, Physiology, and Weed Science College of Science Biology College of Natural Resources and Environmental Sciences Forestry Office of Academic Assessment (OAA) Virginia Bioinformatics Institute (VBI) Virginia Tech Intellectual Properties (VTIP) For more information please contact John McDowell, Principal Investigator, johnmcd@vt.edu

SPECIAL FACILITIES

DEGREES OFFERED

PhD Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE

WATER INTERFACE: INTERDISCIPLINARY RESEARCH TRANSCENDING BOUNDARIES OF ENGINEERING, SCIENCE, AND HUMAN HEALTH

Brenda Davy: bdavy@vt.edu

This Interdisciplinary Graduate Education Program (IGEP) unites graduate students and faculty in 4 colleges and 5 departments in addressing technical and societal challenges of transforming low quality water resources into clean water for healthy living. The Water INTERface program will create a community of doctoral students and faculty that incorporate Blacksburg and Northern Capital Region (NCR) campuses. This community will integrate knowledge of potable water treatment processes with the implications of those processes on water quality, safety and health. IGEP program participants will engage in interdisciplinary research projects to address the four thematic areas described above. Coursework and research experiences will transcend traditional disciplinary boundaries of engineering, science, and human

health. This program will enable all Water INTERface participants to: understand complex societal issues related to water treatment, cleanliness and quality, water consumption and use, and the role of water in human health; develop professional skills for engaging in interdisciplinary research to address the scientific, technical and societal issues associated with these thematic areas; engage in ethical thinking and action in relation to the practice of engineering, science, public policy and health pertaining to water. A graduate certificate is available to those who complete the required coursework (9 credits). Colleges and Departments: College of Agriculture and Life Sciences Human Nutrition, Foods and Exercise Food Science and Technology College of Engineering Civil and Environmental Engineering College of Science Biology College of Liberal Arts and Human Sciences Department of Science and Technology in Society Steven Schoenholtz (CNRE, VA Water Resources Research Center) serves as the liaison with other water research groups on campus and in Virginia. For more information please contact: Brenda Davy, Program Director bdavy@vt.edu Additional information is available on our program website: <http://interdisciplinary.graduateschool.vt.edu/?q=node/14>

SPECIAL FACILITIES

DEGREES OFFERED

IGEP Degree

Offered In (Blacksburg)

TOEFL

Paper: (550.0)

iBT: (80.0)

GRE
