University’s Mission Statement

James B. Duke’s founding Indenture of Duke University directed the members of the University to “provide real leadership in the educational world” by choosing individuals of “outstanding character, ability and vision” to serve as its officers, trustees and faculty; by carefully selecting students of “character, determination and application;” and by pursuing those areas of teaching and scholarship that would “most help to develop our resources, increase our wisdom and promote human happiness.”

To these ends, the mission of Duke University is to provide a superior liberal education to undergraduate students, attending not only to their intellectual growth but also to their development as adults committed to high ethical standards and full participation as leaders in their communities; to prepare future members of the learned professions for lives of skilled and ethical service by providing excellent graduate and professional education; to advance the frontiers of knowledge and contribute boldly to the international community of scholarship; to promote an intellectual environment built on a commitment to free and open inquiry; to help those who suffer, cure disease and promote health, through sophisticated medical research and thoughtful patient care; to provide wide ranging educational opportunities, on and beyond our campuses, for traditional students, active professionals and life-long learners using the power of information technologies; and to promote a deep appreciation for the range of human difference and potential, a sense of the obligations and rewards of citizenship, and a commitment to learning, freedom and truth.

By pursuing these objectives with vision and integrity, Duke University seeks to engage the mind, elevate the spirit, and stimulate the best effort of all who are associated with the University; to contribute in diverse ways to the local community, the state, the nation and the world; and to attain and maintain a place of real leadership in all that we do.

—Adopted by the Board of Trustees on February 23, 2001
The information in this bulletin applies to the academic year 2010-2011 and is accurate and current, to the extent possible, as of May, 2010. The university reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

Duke University prohibits discrimination and harassment, and provides equal employment opportunity without regard to race, color, religion, national origin, disability, veteran status, sexual orientation, gender identity, sex, or age. The university also makes good faith efforts to recruit, employ, and promote qualified minorities, women, individuals with disabilities, and veterans. It admits qualified students to all the rights, privileges, programs, and activities generally accorded or made available to students. The university also does not tolerate harassment of any kind.

Questions, comments or complaints of discrimination or harassment should be directed to the Office of the Vice-President for Institutional Equity, (919) 684-8222. Further information, as well as the complete text of the harassment policy, may be found at: www.duke.edu/web/equity/.

Duke University recognizes and utilizes electronic mail as a medium for official communications. The university provides all students with e-mail accounts as well as access to e-mail services from public clusters if students do not have personal computers of their own. All students are expected to access their e-mail accounts on a regular basis to check for and respond as necessary to such communications, just as they currently do with paper/postal service mail.

Information that the university is required to make available under the Student Right to Know and Campus Security Acts may be obtained from the Office of University Relations at (919) 684-2823 or in writing to 615 Chapel Drive, Box 90563, Duke University, Durham, North Carolina 27708.

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

The Bulletin of Duke University publishes the following titles: The Duke Community Standard in Practice: A Guide for Undergraduates, Divinity School, Fuqua School of Business, Graduate School, School of Law, School of Medicine, Nicholas School of the Environment, School of Nursing, Sanford School of Public Policy, Summer Session, and Graduate Instruction. All bulletins are available online at: http://www.registrar.duke.edu/registrar/studentpages/student/bulletins.html

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Academic Calendar 2010-2011*

The Graduate School.
Consult calendars of the various schools for additional information.

*The dates in this calendar are subject to change. Past, current, and future academic calendars can be found online at http://registrar.duke.edu/registrar/studentpages/studentlinks.html

FALL 2010

August 24 Tuesday. New student orientation
25 Wednesday. 4:00 p.m. Convocation for graduate and professional school students
30 Monday. 8:30 a.m. Fall semester classes begin; Drop/Add continues

September 6 Monday. Labor Day. Classes in session
10 Friday. Drop/Add ends
30 Thursday. 4 p.m. Founders' Day Convocation

October 3 Sunday. Founders' Day
8 Friday. 7:00 p.m. Fall Break begins
13 Wednesday. 8:30 a.m. Classes resume

November 3 Wednesday. Registration begins for Spring semester, 2011
17 Wednesday. Registration ends for Spring semester, 2011
18 Thursday. Drop/Add begins for Spring 2011
23 Tuesday. 10:30 p.m. Thanksgiving recess begins
29 Monday. 8:30 a.m. Classes resume

December 3 Friday. Fall semester graduate classes end
4-13 Saturday-Monday. Graduate reading period; length of the 200-level course reading period is determined by the professor
14 Tuesday. 9:00 a.m. Final examinations begin
19 Sunday. 10:00 p.m. Final examinations end

SPRING 2011

12 Wednesday. 8:30 a.m. Spring semester classes begin. The Monday class meeting schedule is in effect on this day; regular class meeting schedule begins on Thursday, January 13; classes meeting in a Wednesday/Friday meeting pattern begin January 14; Drop/Add continues
13 Thursday. Regular class meeting schedule begins
17 Monday. Martin Luther King, Jr. Day holiday: classes are rescheduled to be held on Wednesday, January 12
26 Wednesday. Drop/Add ends

February 21 Monday. Registration begins for summer 2011
March 4 Friday. 7:00 p.m. Spring recess begins
14 Monday. 8:30 a.m. Classes resume

April 6 Wednesday. Registration begins for Fall semester 2011; Summer 2011 registration continues
15 Friday. Registration ends for Fall semester 2011; Summer 2011 registration continues
16 Saturday. Drop/Add begins for Fall semester 2011
20 Wednesday. Graduate Spring semester classes end
April 21 - May 1  Graduate reading period; length of the 200-level course reading period is determined by the professor
2  Monday. Final examinations begin
7  Saturday. 10:00 p.m. Final examinations end
13  Friday. Commencement begins
15  Sunday. Graduation exercises; conferring of degrees

**SUMMER 2011**

February 21  Monday. Registration begins for all Summer sessions
May 18  Wednesday. Term I classes begin. **The Monday class meeting schedule is in effect on this day;** regular class meeting schedule begins on Thursday, May 19; Drop/Add continues
May 19  Thursday. Regular class meeting schedule begins
May 20  Friday. Drop/Add for Term I ends
May 30  Monday. Memorial Day holiday. No classes are held
June 15  Wednesday. Last day to withdraw with W from Term I classes
June 27  Monday. Term I classes end
June 28  Tuesday. Reading period
June 29  Wednesday. Term I final examinations begin
June 30  Thursday. Term I final examinations end
July 4  Monday. Independence Day holiday observed. No classes are held
July 5  Tuesday. Term II classes begin
July 7  Thursday. Drop/Add for Term II ends
August 1  Monday. Last day to withdraw with W from Term II classes
August 11  Thursday. Term II classes end
August 12  Friday. Reading period (until 7:00 p.m.)
August 12  Friday. Term II final examinations begin, 7:00 p.m.
August 14  Sunday. Term II final examinations end
Administration

GENERAL UNIVERSITY ADMINISTRATION
Richard H. Brodhead, PhD, President
Victor J. Dzau, MD, Chancellor for Health Affairs; and President and Chief Executive Officer, Duke University Health System, Inc.
Peter Lange, PhD, Provost
Tallman Trask III, MBA, PhD, Executive Vice-President
Neal F. Triplett, MBA, President of DUMAC, LLC
Pamela Bernard, JD, Vice-President and University Counsel
Robert M. Califf, MD, Vice-Chancellor for Clinical Research
Kyle Cavanaugh, MBA, Vice-President for Human Resources
Tracy Futhey, MS, Vice-President for Information Technology and Chief Information Officer
Scott Gibson, MBA, Executive Vice-Dean for Administration, School of Medicine
Catherine Lynch Gilliss, DNSc, Vice-Chancellor for Nursing Affairs and Dean of the School of Nursing
B. Hofler Milam, MBA, Vice-President for Finance and Treasurer
Larry Moneta, EdD, Vice-President for Student Affairs
Molly K. O’Neill, MSHA, Vice-Chancellor for Medical Center Integrated Planning; and Vice-President for Business Development and Chief Strategic Planning Officer, Duke University Health System, Inc.
Benjamin D. Reese, Jr., PsyD, Vice-President for Institutional Equity
Richard V. Riddell, PhD, Vice-President and University Secretary
James S. Roberts, PhD, Executive Vice-Provost for Finance and Administration
Michael J. Schoenfeld, MS, Vice-President for Public Affairs and Government Relations
Robert S. Shepard, PhD, Vice-President for Alumni Affairs and Development
Robert L. Taber, PhD, Vice-Chancellor for Corporate and Venture Development
Samuel M. Wells, PhD, Dean of the Chapel
Kevin White, PhD, Vice-President and Director of Athletics
Huntington F. Willard, PhD, Vice-Chancellor for Genome Sciences and Director of the Institute for Genome Sciences and Policy
R. Sanders Williams, MD, Senior Vice-Chancellor for Academic Affairs, Duke Medicine; Senior Advisor for International Strategy
Phail Wynn, Jr., MBA, EdD, Vice-President for Durham and Regional Affairs

GENERAL ACADEMIC ADMINISTRATION
Peter Lange, PhD, Provost
Nancy B. Allen, MD, Vice-Provost for Faculty Diversity and Faculty Development
Bruce W. Cunningham, PhD, Assistant Vice-Provost, University Registrar and Director, Student Service Center
Kimberly Harris, BS, Director, Academic Human Resources
Deborah Jakubs, PhD, University Librarian and Vice-Provost for Library Affairs
David Jamieson-Drake, PhD, Director, Institutional Research
Deborah A. Johnson, PhD, Assistant Vice-Provost and Director of Administrative and Community Support Services
Jacqueline Looney, PhD, Associate Vice-Provost for Academic Diversity and Associate Dean of the Graduate School
Gilbert Merkx, PhD, Vice-Provost for International Affairs and Development
Stephen Nowicki, PhD, Dean and Vice-Provost for Undergraduate Education
Amy Oates, BA, Director, Academic Financial Services and Systems
James S. Roberts, PhD, Executive Vice-Provost for Finance and Administration
Susan Roth, PhD, Vice-Provost for Interdisciplinary Studies
James N. Siedow, PhD, Vice-Provost for Research
John Simon, PhD, Vice-Provost for Academic Affairs
Jo Rae Wright, PhD, Vice-Provost and Dean of the Graduate School

GRADUATE SCHOOL ADMINISTRATION
Jo Rae Wright, PhD, Dean
David F. Bell III, PhD, Senior Associate Dean
Jacqueline Looney, EdD, Senior Associate Dean
Cynthia Robertson, MBA, Associate Dean

EXECUTIVE COMMITTEE OF THE GRADUATE FACULTY
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David F. Bell III, PhD, Senior Associate Dean
Ann Marie Rasmussen (German), Chair
Steven Baldwin (Chemistry), Vice Chair
Melanie Bonner (Psychology)
Merlise Clyde (Statistical Sciences)
Linda Davis (Nursing)
Sheila Dillon (Art, Art History, and Visual Studies)
John French (History)
Sönke Johnsen (Biology)
James Moody (Sociology)
Terrence Oas (Biochemistry)
Lori Setton (Biomedical Engineering)
Raphael Valdivia (Molecular Genetics and Microbiology)
Priscilla Wald (English)
Anne West (Neurobiology)
Thomas Witelski (Mathematics)
Graduate School Faculty
(as of July 1, 2010)

A
Alejandro Aballay, PhD, Associate Professor of Molecular Genetics and Microbiology
Atilla Abdulkadiroglu, PhD, Professor of Economics
Stanley Kenji Abe, PhD, Associate Professor of Art, Art History and Visual Studies
Amy Pichar Abernethy, MD, Assistant Professor of Medical Oncology and Nursing
Mohamed Bahie Abou-Donia, PhD, Professor of Neurology and Pharmacology and Cancer Biology
Soman Ninan Abraham, PhD, Professor of Pathology, Immunology and Molecular Genetics and Microbiology
D. Cory Adamson, MD, Associate Professor of Surgery and Neurobiology
David Aers, PhD, Professor of English
Pankaj K. Agarwal, PhD, Professor of Computer Science and Mathematics
Hengjie Ai, PhD, Assistant Professor of Business Administration
Boris B. Akhremitchev, PhD, Assistant Professor of Chemistry
Syed Munir Alam, PhD, Associate Research Professor of Medicine
Susan C. Alberts, PhD, Associate Professor of Biology and Evolutionary Anthropology
John D. Albertson, PhD, Professor of Civil and Environmental Engineering
John H. Aldrich, PhD, Professor of Political Science
William K. Allard, PhD, Professor of Mathematics
Anne Allison, PhD, Professor of Cultural Anthropology
J. Andrew Alspaugh, MD, Associate Professor of Medicine and Molecular Genetics and Microbiology
Oscar Alzate, PhD, Assistant Research Professor of Neurobiology
Wilfred Amaldoss, PhD, Associate Professor of Business Administration
Andrea Amalfitano, PhD, Associate Consulting Professor of Pediatrics
Elizabeth Oltmans Ananat, PhD, Assistant Professor of Economics and Public Policy Studies
Ruth A. Anderson, RN/PhD, Professor of Nursing
Julie Tetel Andresen, PhD, Associate Professor of English and Slavic Languages and Literature
Edna Andrews, PhD, Professor of Slavic and Eurasian Studies and Cultural Anthropology
Nancy Catherine Andrews, MD/PhD, Professor of Pediatrics and Pharmacology and Cancer Biology
Mark Antilff, PhD, Professor of Art, Art History and Visual Studies
James J. Anton, PhD, Professor of Economics and Business Administration
Carla Antonaccio, PhD, Professor of Classical Studies
James W. Applewhite, PhD, Professor of Emeritus English
Srinivas Aravamudan, PhD, Professor of English and Literature
Peter Arcidiacono, PhD, Associate Professor of Economics
Dan Ariely, PhD, Professor of Economics and Business Administration
Nancy B. Armstrong, PhD, Professor of English
Ashish Arora, PhD, Professor of Business Administration
Vadim Arshavsky, PhD, Professor of Ophthalmology and Pharmacology and Cancer Biology
Steven R. Asher, PhD, Professor of Psychology and Neuroscience
Allison Ashley-Koch, PhD, Associate Professor of Medicine
Alison Hubbard Ashton, PhD, Associate Professor of Business Administration
Robert H. Ashton, PhD, Professor of Business Administration
Paul Stephen Aspinwall, PhD, Professor of Mathematics and Physics
Owen Astrachan, PhD, Professor of Computer Science
Jed W. Atkins, PhD, Assistant Professor of Classical Studies
George James Augustine, PhD, Professor of Neurobiology

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Robin Elizabeth Bowles Bachelder, PhD, Assistant Professor of Pathology
Christian T. Badea, PhD, Assistant Professor of Radiology
Michel Bagnat, PhD, Assistant Professor of Cell Biology
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Lee Baker, PhD, Associate Professor of Cultural Anthropology and Sociology
Paul A. Baker, PhD, Professor of Earth and Ocean Sciences
Steven W. Baldwin, PhD, Professor of Chemistry
Edward James Balleisen, PhD, Associate Professor of History
David L. Banks, PhD, Professor of Statistical Science
Ravi Bansal, PhD, Professor of Business Administration and Economics
Harold U. Baranger, PhD, Professor of Physics
Richard T. Barber, PhD, Professor of Emeritus Biology
Roger C. Barr, PhD, Professor of Biomedical Engineering and Pediatrics
Ana Barros, PhD, Professor of Civil and Environmental Engineering
Julie Vaughn Barroso, RN/PhD, Associate Professor of Nursing
John A. Bartlett, MD, Professor of Medicine and Nursing
Katherine T. Bartlett, JD, Professor of Law School
Cameron Dale R. Bass, PhD, Associate Research Professor of Biomedical Engineering
Steffen A. Bass, PhD, Associate Professor of Physics
Ian Bernard Baoum, PhD, Professor of English
Larry Ryan Baugh, PhD, Assistant Professor of Biology
Patrick Bayer, PhD, Professor of Economics
J. Thomas Beale, PhD, Professor of Mathematics
Charles Becker, PhD, Research Professor of Economics
Sarah Beckwith, PhD, Professor of English and Theater Studies
Michael Douglas Been, PhD, Professor of Biochemistry
Lorena Sue Beebe, PhD, Professor of Biochemistry
Robert Paul Behringer, PhD, Professor of Physics
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Paul Berliner, PhD, Professor of Music
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Jennifer DeVere Brody, PhD, Professor of African and African-American Studies and Theater Studies
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Landon Cox, PhD, Assistant Professor of Computer Science
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Larry B. Crowder, PhD, Professor of Environmental Science and Policy and Biology
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Chicita E. Culberson, PhD, Senior Research Scientist Biology
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Jonathon N. Cummings, PhD, Associate Professor of Business Administration and Sociology
Clifford W. Cunningham, PhD, Associate Professor of Biology
Coleen K. Cunningham, MD, Associate Professor of Pediatrics and Pathology
John F. Curry, PhD, Professor of Psychology and Neuroscience
Stefano Curtarolo, PhD, Associate Professor of Mechanical Engineering and Materials Science

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Brandon Daley, PhD, Assistant Professor of Business Administration
Leslie H. Damasceno, PhD, Associate Professor of the Practice Emeritus Romance Studies
William A. Darity, PhD, Research Professor of Public Policy Studies, Economics and African and African American Studies
Shiva K. Das, PhD, Professor of Radiation Oncology
Michael Bradley Datto, MD/PhD, Assistant Professor of Pathology
Ingrid Daubechies, PhD, Professor of Mathematics
Sandeep S. Dave, MD, Assistant Professor of Medicine
Cathy N. Davidson, PhD, Professor of English
Ellen Davis, PhD, Professor of Religion
Linda L. Davis, RN/PhD, Professor of Nursing
N. Gregson Davis, PhD, Professor of Literature and Classical Studies
Ruth S. Day, PhD, Associate Professor of Psychology and Neuroscience
Neil Barry de Marchi, PhD, Professor of Economics
Scott de Marchi, PhD, Associate Professor of Political Science
Francis de Véricourt, PhD, Associate Professor of Business Administration
Anda Degeratu, PhD, Visiting Assistant Professor of Mathematics
A. Leigh DeNeef, PhD, Professor of English
Susan Denman, PhD, Associate Clinical Professor of Nursing
Jeffrey H. Derby, PhD, Adjunct Associate Professor of Electrical and Computer Engineering
Preyas S. Desai, PhD, Professor of Business Administration
Marc A. Deshusses, PhD, Professor of Civil and Environmental Engineering
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Message from the Dean

At Duke, the Graduate School serves as the intellectual and academic core of the university—the place where we strive to achieve the fullest realization of the institution's two fundamental missions:

- to educate the next generation of teachers, scholars, researchers and professional leaders and
- to develop the fields of knowledge and research within which these leaders will work.

Duke's Graduate School is also uniquely positioned as the natural catalyst for progressive change and innovation across the institution. Over eighty graduate programs actively contribute to and draw from every other school of the university.

Duke presents, therefore, a special academic opportunity: by maintaining a moderate size while engaging faculty, students, and facilities across the boundaries of traditional disciplines, the university is much greater than the sum of its parts. Duke's spirited and integrated intellectual climate continues to attract a broad group of distinguished national and international scholars and scientists.

You will find Duke University to be an institution in its prime—vigourous, vocal, and worthy of the acclaim it has already earned in the global community of scholarship and research. To introduce you to the Duke University Graduate School, then, is to acquaint you with a group of people who are dedicated to the pursuit of excellence.

Jo Rae Wright, Dean
The Graduate School
Duke University
Admission

Degree and Non-degree Admission

Students who wish to undertake graduate work at Duke University, whether for degree or non-degree purposes, must be formally admitted to the Graduate School by the dean. Prerequisites for admission include a bachelor’s degree (or the equivalent of a four-year U.S. bachelor’s degree) from an accredited institution and, for degree programs, satisfactory scores on the Graduate Record Examination (GRE). International applicants (both degree and non-degree) are required to also submit official scores for either the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS). Individual departments may specify additional prerequisites, which can be found in the chapter on “Courses of Instruction.”

Students who do not intend to earn an advanced degree at Duke, but who wish to take graduate courses, may apply for non-degree admission. Such admission is granted in three different categories: (1) admission as a non-degree student affiliating with a particular department; (2) admission through the Office of Continuing Studies as a non-degree student without departmental affiliation; and (3) admission as an unclassified student in the summer session only.

Credits earned by non-degree students in graduate courses taken at Duke before full admission to the Graduate School may be carried over into a graduate degree program if (1) the action is recommended by the student’s director of graduate studies and approved by the dean, (2) the coursework is not more than two years old, (3) the amount of such credit does not exceed one full-time semester, and (4) the coursework received grades of B or better.

Students who have discontinued a program of degree work at Duke must apply for readmission to the Graduate School. Those who discontinue study prior to completing a degree must request in writing permission from the dean of the Graduate School to be readmitted to the degree program. Students who enter the Graduate School in a master’s program must submit a new application to be considered for the doctoral program.

Application Procedures*

A student seeking admission to the Graduate School may access application and program information on the Web at: http://gradschool.duke.edu/admissions/index.php. All parts of the application form must be filled out completely and submitted to the Graduate School Admissions Office with the application fee. The necessary supporting documents must also be sent before or after the submission of the electronic application. The application fee is $75. However, if the application is postmarked and completed by November 8, the fee is reduced to $65. The required supporting documents are: (1) one copy of an official, confidential transcript from each undergraduate or graduate institution attended, sealed in a confidential envelope and signed across the seal by the registrar at the institution; (2) three letters of recommendation; (3) official Graduate Record Examination (GRE) General Test scores for applicants to all programs except the Master of Arts in Liberal Studies; and (4) official scores on the GRE Subject Tests for applicants to certain specified departments. Additional requirements for international applicants are described below.

Materials submitted in support of an application are not released for other purposes and cannot be returned to the applicant.

Students applying for fall admission and award should take the GRE in time for official scores to reach

*This chapter is a brief summary of information available from the Graduate School Admissions Web page online at: http://gradschool.duke.edu/admissions/index.php. This Web page should be consulted for more comprehensive information on all aspects of the application, admission, and award process.

**All fees are based on current charges and are subject to change without notice.
the Graduate School by the December 8 deadline. Information on the dates and places of the Graduate Record Examinations can be obtained from the applicant’s college or the Educational Testing Service GRE Web site: http://www.gre.org.

**Additional Procedures for International Students.** If a student’s native language is not English, an international student must, in addition to the information required of all students, submit certification of English proficiency demonstrated by official test scores from the International English Language Testing Service (IELTS) (http://www.ielts.org), or the Test of English as a Foreign Language (TOEFL) (http://www.toefl.org). The Graduate School requires a minimum IELTS score of 7.0 or a minimum TOEFL score of 83 on the internet-based test (iBT).

International students must also submit a statement showing financial arrangements for the proposed term at Duke. Estimated costs per academic year are approximately $60,000 for the doctoral program and $46,000 for the master’s programs.

**English Language Requirements for International Students.** The Graduate School requires that all incoming international students whose first language is not English demonstrate proficiency in speaking and writing English. All new students whose first language is not English must take the proficiency examinations given before or during their first semester at Duke. Depending on their exam results, students are either exempted from or placed into one or more EIS courses. Students with EIS requirements must begin these courses in their FIRST year of study.

**Part-Time Graduate Study.** Some graduate departments will consider applications from students wishing to pursue degree study on a part-time basis. (Consult application materials for listing of departments.) Admission requirements, procedures, and deadlines are the same for part-time study as for full-time study. Visa restrictions do not allow international students to pursue graduate study on a part-time basis.

**Summer Session Procedures.** Students who wish to begin graduate work during the summer must check first with the department of interest concerning available courses or research work, as well as funding possibilities; some departments have summer offerings and others do not. Applications should be submitted according to the fall deadline schedule, since summer files will be reviewed along with others who plan to begin in late August.

**Continuing Studies Procedures.** A student seeking admission as a non-degree continuing studies graduate student at Duke must have received a bachelor’s degree from a fully accredited college of university. More information regarding continuing studies at Duke is available on the Duke University Continuing Studies Web site: http://www.learnmore.duke.edu.

**Review of Application and Notification of Status.** All applications are considered without regard to race, color, religion, national origin, disability, veteran status, sexual orientation or gender identity, sex, or age.

Application files are assembled in the Graduate School Admissions Office, where all official record-keeping is maintained. Applications, once processed, are sent to the departments. A departmental admissions committee, usually headed by the director of graduate studies, reviews the applications and makes recommendations to the dean of the Graduate School. Formal admission to the Graduate School is offered only by the dean. The process of admission is not complete until the student accepts the offer of admission by submitting the online enrollment form.

Admission may not be deferred from one term to another: an admission offer is only for the semester, program and degree specified in the letter of admission. Students seeking the AM or MS degree must re-apply for admission to a PhD program.

**Immunizations.** North Carolina Statute G.S.: 130A-155.1 states that no person shall attend a college or university, public, private, or religious, excluding students attending night classes only and students matriculating in off-campus courses, unless a certificate of immunizations against diphtheria, tetanus, whooping cough, poliomyelitis, red measles (rubeola), and rubella is presented to the college or university on or before the first day of matriculation. The required forms and instructions are provided to students after their acceptance of the offer of admission.

**Deadlines for Application**

It is the applicant’s responsibility to make certain that the Graduate School Admissions Office has received all required materials by the appropriate deadlines. Only complete applications can be considered. To ensure that the Graduate Admissions Office will have adequate time to assemble all items submitted on an applicant’s behalf, applications should be sent at least two weeks before the stated deadlines.

Consult current application materials for a more detailed explanation of deadlines and their enforcement.

**FOR FALL SEMESTER**

**November 8th.** Deadline for submission of applications eligible for the reduced application fee of $65. All
applications submitted after this date must be accompanied by a fee of $75 or they will not be processed.

**December 8th.** Priority deadline for admission and award to PhD programs for the fall semester.

**January 30th.** Priority deadline for admission to master’s programs for the fall semester.

Applications submitted after these dates are not guaranteed consideration but will be considered for admission if all spaces have not been filled, and for financial aid, if funds are still available. All PhD students seeking fall admission should meet the December 8th deadline, since it is likely that enrollment in many departments will be filled soon after this date. The final cut-off date for processing new applications is June 30. Few departments, however, continue to review applications this late. No applications for fall received after this date will be processed.

**May 15.** Deadline for application to the Master in Liberal Studies program.

**SPRING SEMESTER**

**October 15.** Final date for completion of applications for admission to the spring semester, space permitting. Not all departments accept new students for the spring semester, nor is financial aid readily available for spring matriculants.

**SUMMER SESSION**

Students seeking admission to the Graduate School for study in the summer session should apply for Graduate School admission according to the fall deadline schedule. There are two Summer Sessions, typically running from mid-May to late June, and early July to mid-August.
Financial Information

Fellowships and Scholarships

The contributions of graduate students are highly valued in the university and Duke has a strong commitment to financially support the students it selects for graduate study. The Duke University Graduate School and its graduate programs offer a wide array of financial support. Funding is available from annually allocated awards funds, instruction, endowed fellowships, foundation and other private support, as well as federal research grants, training grants, and fellowships.

Selection of University award recipients is made on the basis of academic merit and departmental recommendations. Incoming students who wish to be considered for any of the institutional fellowships or assistantships mentioned in this section should so indicate on the application form for admission and award. Continuing students interested in applying for University awards for advanced students should follow the application procedures listed on the Graduate School Web site and/or in the award announcement.

GRADUATE STUDENT FUNDING AT DUKE

Students studying for the PhD are typically supported for a period of five years. Standard support packages for PhD students may include a scholarship that covers all or a portion of tuition and fees, health insurance, and a fellowship stipend and/or assistantship to help defray cost of living expenses. Students in humanities and social science departments are supported for nine months, with summer fellowship support available for advanced students on a competitive basis. In natural science departments 9 month awards are also typical although summer support for PhD students from research and/or departmental funds is frequently available. In the biomedical sciences and engineering departments support is typically provided for 12 months. For students pursuing the master of arts and master of science degrees, some limited funds for tuition scholarships may be available. These are awarded by the individual departments and programs.

DEPARTMENT AND PROGRAM FELLOWSHIPS AND ASSISTANTSHIPS

The majority of funding available for graduate study is provided by the student’s department or program. For information about student funding in a specific department or program, students should contact the director of graduate studies. In general, a student’s support package may be composed of several different types of funding, including:

• Full or partial scholarships to cover tuition and fees
• Fellowship stipends, which require no work service, and are awarded by the department or program. Many departments, including Chemistry, Economics, English, Psychology, and Religion also offer endowed fellowships. Selection for these fellowships is usually made by faculty committee within the individual department.
• Training grant appointments, for US citizens and permanent residents participating in federally funded training programs
• Research Assistantships are available for graduate students whose special training and qualifications enable them to serve as assistants to individual faculty members in certain departments.
• Teaching Assistantships, which are part-time opportunities offered to qualified graduate students for work as instructors, preceptors and section leaders, tutors, and graders.

Several departments utilize, when possible, the federal work study program to help fund teaching and graduate assistantship positions. As a result, some departments may require or request that students complete the Free Application for Federal Student Aid so that eligibility for work study funds can be determined. This form can be completed online at the Free Application for Federal Student Aid Web site (http://www.fafsa.ed.gov).

Interdisciplinary Programs and Centers

In addition to the departmentally based awards, several interdisciplinary programs and centers offer fellowship and assistantship awards to both incoming and continuing students interested in the program areas. These include programs in Documentary Studies, Medieval and Renaissance Studies, Women’s Studies, and centers such as the Kenan Center for Ethics and the John Hope Franklin Center for Interdisciplinary and International Studies.
COMPETITIVE GRADUATE SCHOOL FELLOWSHIPS

The Graduate School funds several competitive fellowships for incoming and continuing students. For incoming students selection is based on departmental nomination during the application process. Continuing students should follow the application procedures listed on the Duke University Graduate School Financial Support Web site: http://gradschool.duke.edu/financial_support/index.php.

Students holding a competitive graduate school fellowship are not permitted to hold other fellowships or Duke employment concurrent with the graduate school award without prior approval from the dean of the graduate school. Exceptions to this are the Summer Research and Dean’s Graduate Summer Fellowships, which can be held with any other University or external award provided the student continues to make adequate progress toward degree completion. Typically, fellowships for both incoming and continuing students will provide a full tuition and fee scholarship, health insurance, and a 9 or 12 month stipend depending on the student’s program of study. Some awards also provide stipend supplements to the standard departmental stipend, research and/or travel expense reimbursement.

Fellowships for Incoming Students

James B. Duke Fellowships. The James B. Duke One-Hundredth Anniversary Fund provides fellowships for students who wish to pursue a program leading to the PhD degree in the Graduate School at Duke University. Its objective is to aid in attracting and developing outstanding scholars to Duke. Selection of recipients is made by a faculty committee upon nomination by the appropriate department. These fellowships provide a $5,000 stipend supplement for four years to any other award the student receives from the department, the Graduate School, or external source.

The University Scholars Program was created in 1998 with a gift from former Duke University Trustee Melinda French Gates and her husband Bill Gates, through the William H. Gates Foundation. The program is designed to stimulate an interdisciplinary, intergenerational, and diverse community of scholars. Each year the University Scholars Program provides tuition and fee scholarships, health insurance, and a nine-month stipend for up to six incoming graduate students, who participate in bimonthly University Scholars Program seminars, and act as informal intellectual leaders and mentors (not advisors) to the program's undergraduates. For more information, visit the University Scholars Program Web site: http://www.usp.duke.edu.

Dean’s Graduate Fellowships are awarded to students who, by reason of their background, culture, socioeconomic status, race, ethnicity, work and life experiences, contribute to a fuller representation of perspectives within the academic life of the university. Nominees must be U.S. or naturalized citizens. The fellowship is a four-year award, provided by the Graduate School in conjunction with the admitting department, and offers a full tuition, health and recreation fee scholarship as well as a scholarship covering the Duke student medical insurance premium. The Graduate School provides academic year stipend support in years one and two, and summer support or a $5,000 stipend supplement, for all four years depending on the student’s program of study. Academic year stipend support in years three and four is provided through normal departmental mechanisms and may require service in the form of a research, teaching, or graduate assistantship. In the fifth or final years of study, fellows are also eligible to compete for dissertation support.

Pratt-Gardner Fellowships, funded through the W.H. Gardner, Jr. Society of Engineering Fund, provide funding for students in the Pratt School of Engineering who wish to pursue a program leading to the PhD. The fellowship program’s objective is to aid in attracting and developing outstanding scholars at Duke University. Selection of award recipients is made by a faculty committee upon nomination by the engineering departments. These fellowships, approximately five per year, provide payment of full tuition, health and recreation fees, health insurance, and a 12-month stipend. More information can be found at the Pratt School Graduate Fellowships Web page: http://www.pratt.duke.edu/graduate-fellowships.

Chancellor’s Scholarships are awarded to incoming graduate students studying biomedical sciences in the School of Medicine, and provide a one-time $5,000 supplement to the standard departmental award package. Students receiving this meritorious award will be designated as Chancellor’s Scholars, and will be invited to meet with Chancellor Victor Dzau and other award recipients at the annual Chancellor’s Scholars dinner.

Latin American Studies Fellowships are awarded on a competitive basis to students interested in Latin American studies at Duke. Fellowship recipients are expected to participate in Latin American studies program activities and to take Latin American studies courses, both within and outside their admitting departments. This one-year fellowship provides tuition and fees scholarships, coverage of Duke student medical insurance, and an academic year stipend.

Fellowships for Continuing Students

Katherine Stern, Julian Price, and Evan Frankel Fellowships provide dissertation-year support for advanced PhD students. These fellowships include tuition and fees scholarships, health insurance, and a nine-month stipend to allow graduate students to focus on their dissertation research and writing in their final years of study. The Julian Price Fellowship provides an additional $5,000 award to cover travel and other costs associated with dissertation research.

Bass Fellowships for Undergraduate Instruction are awarded each year to several advanced PhD students. Students are required to teach one course during the academic year in which they hold the award.
Summer Research Fellowships for students in Humanities and Social Sciences are available to students who have passed their preliminary exams, in the summer following years three through six. These fellowships are generally funded through a number of graduate school endowments and provide a summer tuition and health fee scholarship, and a three-month stipend.

Library Internships. The Graduate School and Perkins Library offer four nine-month internships each year to students working with special library materials.

Aleane Webb Dissertation Research Fellowships provide support ranging from $250 to $500 for incidental research expenses associated with dissertation completion.

Sigma Xi. Both the national and local chapters of this scientific honorary society offer research grants to graduate students. The Graduate School currently provides matching funding for these awards.

Conference Travel Awards fund advanced students who are presenting papers at national conferences.

International Research Opportunities

The Graduate School also works to secure funding for advanced students who need to conduct research overseas in order to complete their dissertation projects. Below are a few of the programs currently available.

Advanced International Fellowship. This fellowship provides tuition and fee scholarships, Duke student medical insurance coverage, and an academic year stipend for one or two advanced students conducting research overseas per year.

Predissertation/Dissertation Travel Awards are provided for overseas research travel. Awards range from $500 to $3,000, based on the budget submitted by the student as part of the application process, but typically averages $2,600 per student.

Organization for Tropical Studies. The OTS provides limited funding to cover the cost of tuition and partial travel expenses, if possible, for students participating in this program in Costa Rica. For more information on this opportunity, visit [http://researchfunding.duke.edu/detail.asp?OppID=2970](http://researchfunding.duke.edu/detail.asp?OppID=2970).

Exchange Programs. The Graduate School has developed exchange programs with a number of foreign universities, including the Free University of Berlin, Potsdam, Humboldt University, University of Salzburg, Trinity College-Dublin, University of Venice, University of Vienna, and the University of Erlangen-Nuremberg.

NATIONAL, REGIONAL, AND FOUNDATION AWARDS

In addition to those awards available through the university, applicants are urged to compete for national and foundation awards available for graduate study. The Duke University Office of Research Support Web site ([http://www.ors.duke.edu/](http://www.ors.duke.edu/)) lists awards available from a variety of federal and private sources, as well as awards funded by the university. External awards, which are prestigious and a valuable acknowledgement of a student’s intellectual project and promise, typically replace departmental or Graduate School awards.

The Graduate School offers numerous other scholarships, fellowships, and miscellaneous awards for continuing students. A complete listing, description of awards, and application materials for graduate school fellowships, as well as links to other external awards and funding sources can be found on the Graduate School Financial Support Web page: [http://gradschool.duke.edu/financial_support/](http://gradschool.duke.edu/financial_support/).

PAYMENT OF AWARDS

Students must be enrolled in the Graduate School in order to receive fellowship or assistantship support. The payment of graduate assistantships starts on September 25 and is made in equal payments on the twenty-fifth day of each month thereafter. Fellowship stipends are paid on the last working day of the month, beginning in September.

Under the Tax Reform Act of 1986, both fellowship stipends and assistantships are taxable. For U.S. citizens, fellowship stipends may be reduced, for tax purposes, by the amounts paid for tuition, fees, and required books, supplies, and equipment. For general information about the taxability of scholarships and fellowships, students should review IRS publication 970, which can be found on the Internal Revenue Service Web site: [www.irs.gov](http://www.irs.gov). For foreign students, stipend payments are subject to withholding of federal and state income taxes, based on the existing tax treaty between the student’s country and the USA. Information concerning tax treaties by country can be found on the Internal Revenue Service Web site: [www.irs.gov](http://www.irs.gov). In addition, the IRS requires that tuition payments for foreign students must be reported to the federal government. Since each student’s tax situation is unique, the Payroll Office at Duke provides assistance to enrolled students regarding withholding requirements.

Students have ultimate responsibility for ensuring that their tuition and fees are paid. Students should review statements received from the Bursar’s Office regularly and quickly resolve payment problems or issues that arise. Students with questions about their bursar accounts should contact the assistant to the director of graduate studies.
in their department, the Bursar’s Office, or the Graduate School Office of Budgets and Finance.

**Satisfactory Progress.** Graduate students are expected to make satisfactory progress in their programs in order to remain enrolled in the Graduate School or to receive financial aid. Qualitative and quantitative requirements regarding formal coursework are detailed in the chapter of this bulletin entitled “Regulations” on page 44. This chapter also includes regulations regarding unsatisfactory or failing grades. Additional requirements may be imposed by individual departments. Departments are responsible for certifying at the conclusion of each academic year the satisfactory progress of all enrolled students. Finally, the Graduate School has established normative time requirements for completion of various stages of graduate degree work. Failure to meet expected time frames requires a review of the student’s situation by the Dean of the Graduate School, as specified in the chapter on “Regulations” on page 44.

**LOANS**

Students who anticipate a need to supplement their financial resources through loans or college work-study employment must complete a Free Application for Federal Student Aid form. Students are encouraged to complete the FAFSA online at: [http://www.fafsa.ed.gov](http://www.fafsa.ed.gov). In order for Duke Graduate School to obtain the information electronically, Duke’s school code (E00165) must be indicated on the form.

Students who are enrolled at least half time, who are U.S. citizens or permanent residents, and who meet the federal criteria for need are eligible for loans. Loan funds are provided through the Carl Perkins Student Loan Program after a student has borrowed the maximum from the Federal Stafford Loan Program. Subsidized Stafford and Carl Perkins loans do not accrue interest charges while the borrower maintains student status, as well as during a short period thereafter. Interest during the repayment period is at a favorable rate. Additional loan funds needed to meet a student’s budget may come from the Graduate PLUS loan program, or a private, alternative loan program.

Inquiries should be addressed to the Financial Aid Coordinator, Box 90061, Graduate School, Duke University, Durham, North Carolina 27708-0061.

**WORK-STUDY PROGRAM EMPLOYMENT**

Funds are available through the college work-study program for short-term or part-time employment of graduate students. A student who wishes to apply for work-study must complete a Free Application for Federal Student Aid online at [www.fafsa.ed.gov](http://www.fafsa.ed.gov). Students considering the possibility of work-study for the fall should submit FAFSA forms by April 1. Eligibility requirements are similar to those of the federal loan programs. Awards are based on the job, eligibility of the student, and availability of funds. In addition to departmental employment opportunities, the Duke University Career Center ([http://career.studentaffairs.duke.edu/graduate/index.html](http://career.studentaffairs.duke.edu/graduate/index.html)) maintains a listing of employment opportunities for students.

**Student Expenses**

Although many students will receive financial assistance for their graduate education, students are responsible for ensuring that they have the means to support themselves, and the ability to pay tuition and fees due the university. Below is a summary of expected costs.

**COST OF LIVING**

For a specific estimate of the cost of education for need-based awards or loan certification, contact the Graduate School Financial Aid Office.

**TUITION**

The following figures are estimates for 2010-2011 and are subject to change.

**PhD Tuition** is charged on a per semester basis. For 2010-2011, the tuition charge for PhD students in their first three years of study is $19,575 per academic semester. Upon approval of the dean, one semester of credit may be granted for PhD candidates entering with a previous graduate degree or for one semester of nondegree work done at Duke prior to matriculation. Students in their fourth year of study and beyond are charged a reduced tuition rate of $2,755 per academic term. All students, regardless of year of study, are charged the reduced tuition rate of $2,650 for the summer term.

**Master’s, Non-degree, and Part-time PhD Tuition** is charged on a per credit unit basis at $1,125 per credit unit. Typical courses are three credits, although some may be one, two, or four depending on the course. Master’s candidates, non-degree, and part-time graduate students are also charged a per semester registration fee of $2,755.

**TRANSCRIPT FEE**

All entering students will be charged a one-time mandatory fee of $40 for transcripts. This fee entitles the student to an unlimited number of Duke transcripts. Requests for transcripts of academic records can be made via ACES, Duke’s online student records system. ACES can be accessed via the Office of the University Registrar’s Web page: [http://registrar.duke.edu](http://registrar.duke.edu).
STUDENT HEALTH FEE
All full-time students and part-time degree candidates are assessed a fee each semester for the use of the Student Health Service. For fall and spring the fee is estimated at $580 ($290 per semester). For summer the fee is estimated at $186. This fee is distinct from health insurance and does not provide major medical coverage. For the services covered by this fee see the Student Life chapter in this bulletin.

HEALTH INSURANCE
Students will be charged for health insurance in the fall semester, unless proof of other health insurance is provided. For 2010-2011, health insurance is estimated to be $1,750 for the full year.

STUDENT GOVERNMENT DUES
All graduate students will be charged student government dues of $16.25 per academic semester.

RECREATION FEE
All graduate students will be charged a recreation fee for the use of on-campus facilities. The fee is $34 per semester.

OTHER FEES

**Thesis or Dissertation Fees.** Fees incurred in connection with a thesis or dissertation are subject to change:

- Binding fee, two university copies of thesis (master’s only) $18
- Archiving fee (doctoral degree only) upon final submission $65
- Copyright fee (doctoral degree only), optional $65

**Marine Laboratory Fee.** For Marine Laboratory investigators’ research table fee, please contact the Nicholas School of the Environment.

**Audit Fee.** Auditing classes is permitted on a space available basis with the consent of the instructor. Students registered full time during fall and spring may audit courses without charge. An audit fees is charged for other students.

**Parking Fee.** Students should contact the University Parking and Transportation Services Office regarding parking fees.

PAYMENT OF ACCOUNTS FOR FALL AND SPRING
The Bursar’s Office e-mails statements to registered graduate students for tuition, fees, and other charges approximately four to six weeks prior to the beginning of classes each semester. The amount due on the statement is payable by the due date listed on the statement. Student account statements are also available online. Inquiries regarding statements can be directed to the Bursar’s Office at: bursar@duke.edu or (919) 684-3531.

As part of the admission agreement to Duke University, students are required to pay all statements as presented. If full payment is not received, a late payment penalty charge on the past due amount is charged on the subsequent statement. The past due amount is defined as the amount due from the previous statement minus payments, financial aid, loans and other credits received prior to the due date listed on the prior statement.

Failure to receive an invoice does not warrant exemption from the payment of tuition and fees nor from the penalties and restrictions. Non-registered students will be required to make payment for tuition, fees, and other charges at the time of registration.

In addition to late payment charges, students with accounts in default may be subject to the following restrictions:

- Blocked from registering for future terms
- Blocked from access to copies of transcript of academic records
- Not able to have academic credits certified
- Not be permitted to go on leave of absence
- Not eligible to receive a diploma at graduation
- Subject to withdrawal from the university
- Subject to having the past due student account referred to a collection agency and credit bureaus

**Refunds for Withdrawal from School during Fall and Spring Semesters.** In the event of death, refund of full tuition and fees for the term will be granted. In all other cases of withdrawal from the university, students may have tuition refunded according to the following schedule:

- Withdrawal before classes begin: full refund, including fees
- Withdrawal during the first or second week of classes: 80% refund *
• Withdrawal during the third, fourth, or fifth week of classes: 60% refund*
• Withdrawal during the sixth week of classes: 20% refund*
• Withdrawal after the sixth week: no refund

*Fees are not refunded after the start of the term.

If a student has to drop a course for which no alternate registration is available, drops special fee courses (music, golf, etc.), or drops a paid audit during the first two weeks of the drop/add period, a full refund may be granted with the approval of the dean. The student health fee will not be refunded.

**Special Tuition Benefits for Employees.**

The University provides a tuition assistance benefit to eligible employees enrolled in coursework at Duke. Additional information is available on the Duke University Human Resources Educational Benefits Web page: www.hr.duke.edu/benefits/education.
Registration

Registration Requirements. All students must register each fall and spring semester, and pay the requisite tuition and fees for each semester until all degree requirements are completed, unless this requirement is waived by an approved leave of absence granted by the dean. Failure to maintain continuous registration each fall and spring will result in administrative withdrawal from the university.

Leave of Absence. Students who have been on leaves of absence and who intend to resume a degree program must give the department and the dean notice of this intention two months before registration.

Doctoral students. In addition to “Continuation,” doctoral students must also register for a total of 6 semesters of full-time tuition. For PhD students, approved transfer of an earned graduate degree may reduce the number of semesters of full-time tuition required for the degree to 5 semesters. After the 6 semesters of tuition, doctoral students will be charged a reduced tuition. Specific course requirements for doctoral students are set by the degree-granting programs and departments. Students must be registered during the terms when they take qualifying, preliminary, and final examinations, and when they submit dissertations in final form to UMI/ProQuest and DukeSpace.

Master’s students. Full-time master’s candidates must register for at least 9 units per semester until a minimum of 30 units of degree credit have been achieved (some programs require more than 30 units to obtain a degree). Full-time students can enroll for fewer than 9 units only during the final semester when they are completing the required degree credits in their program. A registration fee and “Continuation” registration for each semester are also required in all master’s programs. Approved transfer course work into a master’s program will not reduce the minimum registration of 30 units for a master’s degree at Duke University. Students must be registered during the terms when they take final examinations and submit their theses.

Registration Periods. All students who are enrolled in the Graduate School and who have not been granted a leave of absence by the dean must register each fall and spring until all degree requirements are completed. New students will register immediately prior to the first day of classes in either term; continuing students register during the announced registration periods (set by the Registrar’s Office) in November and April.

Late Registration. All students are expected to register at the times specified by the university. A late registration fee of $25 is charged any student registering late, including a current student who delays registering until the registration date for new students.

Summer Registration. Students who are in residence at Duke University during the spring and who plan to enroll in courses in the summer session should have their course programs approved by the director of graduate studies. Summer session students should register at announced times beginning with the February registration period and up to the Wednesday preceding the start of the appropriate term. Graduate students who are conducting research related to their degree and/or are receiving support through university fellowships or assistantships during the summer session, but are not enrolled in any courses, pay a reduced tuition.

The university does not mail statements for summer session tuition and fees. All tuition and fees should be paid in the Office of the Bursar or the Student Service Center at least five full working days prior to the first day of class (see summer session calendar). Students who fail to register and pay all tuition and fees before this deadline will be assessed a penalty by the Bursar. Failure to pay tuition and fees by the end of the drop/add period will result in administrative withdrawal of the student.

Summer session students may add a course or courses before or during the first three days of the term. Courses may also be dropped before and during the first three days, but a 20 percent tuition fee will be charged (1) if the course is not dropped before the first day, and (2) the dropped course(s) results in a total tuition reduction. Courses dropped after the third day of classes are not eligible for tuition refund.

Full-time students in any degree program may audit courses without charge during the fall and spring semesters, if this is acceptable to the faculty teaching these courses. Students should obtain faculty permission prior to registering for the class. If the student is not in full-time status, an audit fee is charged.
Regulations

General Academic Regulations

Credits. The following regulations pertain to credits earned outside the Duke University Graduate School:

Graduate Credit Earned before the AB Degree Is Granted. Ordinarily no credit will be allowed for graduate courses taken before a student has been awarded the AB or BS degree. However, an undergraduate student at Duke University, who at the beginning of the final semester lacks no more than three courses in order to fulfill the requirements of the bachelor’s degree, may apply for admission to the Graduate School for that final semester. If the student meets the requirements for admission, permission may be obtained from the dean of the Graduate School to enroll for graduate courses to bring the student’s total academic program to no more than four courses. While remaining registered as an undergraduate, the student must also register as a graduate student and pay tuition for any graduate courses to the Graduate School at the beginning of the semester in which graduate credit is to be earned in order for the courses to be credited toward a graduate degree program.

Transfer of Graduate Credits. For master’s programs, the transfer of graduate credit does not reduce the required minimum registration of 30 units for a master’s degree at Duke. For PhD students, one semester of full-time tuition credit may be given if the student has completed a relevant graduate degree at another institution. No transfer credits will be awarded to those students who wish to receive a master’s degree en route to the PhD. Financial credit for the above programs will be given only after the student has completed one full-time semester in a degree-granting graduate program. (For PhD students, departments are free to consider previous course work in determining further course requirements for the student—academic credit is distinct from financial credit or registration requirements for the PhD degree.)

Grades. Beginning with the fall 2004 semester, grades in the Graduate School are as follows: A, B, C, F, and I. I (incomplete) indicates that some portion of the student’s work is lacking, for an acceptable reason, at the time the grades are reported. For students enrolled in the Graduate School, the instructor who gives an I for a course specifies the date by which the student must make up the deficiency. However, if a course is not completed within one calendar year from the date the course ended, the grade of I becomes permanent and may not be removed from the student’s record. The grade of Z indicates satisfactory progress at the end of the first semester of a two-semester course. For non-degree graduate students enrolled in the summer session, a temporary I for a course may be assigned after the student has submitted a written request. If the request is approved by the instructor of the course, then the student must satisfactorily complete the work prior to the last day of classes of the subsequent summer term. A grade of F in a major course normally occasions withdrawal from a degree program. In order to be certified as making satisfactory progress towards the degree, graduate students must maintain at least a 3.0 (B) cumulative grade point average. Students falling below this average jeopardize not only their financial support, but their continuation in the graduate program. To remain in good academic standing in a program, a student must, in addition, demonstrate satisfactory progress in research and related activities beyond coursework. Degree programs may establish additional criteria that students must meet to remain in good academic standing.

Reciprocal or Interinstitutional Agreements with Neighboring Universities. Under a plan of cooperation between Duke University and the University of North Carolina at Chapel Hill, North Carolina Central University, and North Carolina State University, full-time students properly enrolled in the Graduate School of Duke University during the regular academic year, and paying full tuition to this institution, may be admitted to a maximum of two courses per semester at one of the other institutions in the cooperative plan. Under the same arrangement, students in the graduate schools in the neighboring institutions may be admitted to course work at Duke University. Credit so earned is not defined as transfer credit. To take advantage of this arrangement during either summer session term, the student registers for 3 units of credit at the home institution and 3 units of credit at the other institution, for a total of 6 units. All interinsti-
tutional registrations involving extra-fee courses or special fees required of all students will be made at the expense of the student and will not be considered a part of the Duke University tuition coverage. This reciprocal agreement does not apply to contract programs such as the American Dance Festival.

**Identification Cards.** Graduate students are issued identification cards that they should carry at all times. The card is a means of identification for library privileges, athletic events, and other university functions or services open to university students. Students will be expected to present their cards on request to any university official or employee. The card is not transferable, and fraudulent use may result in loss of student privileges or dismissal from the Graduate School. A lost card must be reported immediately to the Duke Card Office.

**Courses Primarily for Undergraduates.** With the approval of their director of graduate studies, graduate students may enroll in undergraduate courses to round out their programs of study. Students pursuing a master’s degree are limited to two undergraduate courses (at the 100 level or above); doctoral students may take as many as required. In either case, students must receive a grade of B- or better to have such courses counted as part of their earned graduate credit.

**Withdrawal from a Course.** For permissible changes during the drop/add period of the fall or spring semester and during the first three days of summer session term, see the chapter on “Registration” on page 43. If a course is dropped after the drop/add period during the fall or spring or after the first three days of classes during the summer, a Withdraw (W) will be noted on the permanent record.

**Interruption of Program and Withdrawal from the Graduate School.** Students are expected to meet academic requirements and financial obligations, as specified elsewhere in this bulletin, in order to remain in good standing. Certain nonacademic rules and regulations must be observed also (see “Standards of Conduct” on page 49). Failure to meet these requirements may result in summary dismissal by the appropriate officer of the university. The university reserves the right, and matriculation by the student is a concession to this right, to request the withdrawal of any student whose academic performance at any time is not satisfactory to the university. A student who wishes for any reason to withdraw from the Graduate School during the fall, spring, or summer session must notify in writing both the director of graduate studies in the major department and the dean of the Graduate School prior to the date of the expected withdrawal and no later than the published last day of classes for that semester or summer session. If students wish to withdraw from courses in the summer session, they must consult both the director of graduate studies in the major department and the director of the Summer Session. For refunds upon withdrawal, see the chapter on “Financial Information” on page 42.

A student who, after successfully completing one semester of graduate study, must withdraw before completion of a graduate program may, with the approval of the major department, request the dean to issue a certificate of graduate study.

**Leave of Absence.** A leave of absence for a period of time no longer than one calendar year may be granted because of medical necessity, full-time employment, receipt of an external award, or other acceptable reasons. A request for a leave of absence should be originated by the student, endorsed by the student’s major professor and director of graduate studies, and submitted to the dean of the Graduate School for consideration prior to the beginning of the semester for which the leave is requested. A student is eligible to request a leave of absence only after having completed at least one semester at Duke. Time limitations that pertain to the various degrees and the completion of courses on which a grade of Incomplete (I) was earned are not waived during leaves of absence.

Students contemplating leaves of absence for reasons other than medical emergency should be aware that, for financial purposes, all guarantees of financial support are calculated from the date of initial matriculation. For example, if a graduate program has stated that a student will be supported through the fifth year of graduate study and the student subsequently takes a leave of absence for one of those years for reasons other than medical emergency, the student would forfeit a year of institutional support.

**English Proficiency for International Students.** All international students whose first language is not English must enroll in appropriate sections of English for International Students during their initial year at Duke, unless formally waived from this requirement by the Graduate School upon certification of competency in English.

**Library Privileges.** Graduate students are entitled to carrels only if registered as full-time students. Only students who have attained candidacy (passed the preliminary examination) are eligible for closed carrels.

**Student Health and Insurance.** The Student Health Fee entitles the student to outpatient treatment through the University Student Health Program, inpatient treatment in the University Infirmary, and services provided by Counseling and Psychological Services. The health fee should not be confused with the Duke Student Medical Insurance Plan, which covers a large number of medical costs above and beyond the treatment available through the University Health Program. Full-time students who are entitled to coverage by the Student Health Program are also eligible for the supplementary insurance policy.
All students enrolled in programs that require payment of the health fee must also have adequate medical insurance. Students will automatically be enrolled in the Duke Student Medical Insurance Plan unless they submit a waiver indicating that they are covered by a comparable plan. Students indicate their health insurance decision through online student records as part of Duke’s online registration process. The University requires all students to be responsible for health costs over and above what is covered by the student health fee. For international students holding J-1 or F-1 visas, participation in the Duke Student Medical Insurance Plan is mandatory and no insurance decision in ACES is necessary—they will automatically be enrolled in and charged for the Duke plan.

Degree Regulations—The Master’s Degrees

MASTERS OF ARTS/MASTER OF SCIENCE

Prerequisites. As a prerequisite to graduate study in the major subjects, a student must have completed a minimum of 24 undergraduate semester hours—ordinarily 12 semester hours of approved college courses in the major subject and 12 semester hours in the major or in related work. Since some departments require more than 12 semester hours in the proposed field of study, students should read carefully the special requirements listed by their major departments in the chapter on “Courses of Instruction.” If special master’s requirements are not specified in this chapter and there is a question about prerequisites, prospective students should write directly to the appropriate director of graduate studies.

Language Requirements. The Graduate School requires no foreign language for the master’s degree. Certain departments, however, do have language requirements and these must be satisfied before the master’s examination can be taken. See the departmental listings in the chapter on “Courses of Instruction.”

Major and Related Subjects. Thirty units of graduate credit at Duke constitutes minimum enrollment for the Master of Arts and the Master of Science degrees. Students must present acceptable grades for a minimum of 24 units of graded course work, 12 of which must be in the major subject. Six units of the required 24 is often in a minor subject or in a related field which is approved by the student’s major department. Individual programs and departments decide whether the MA/MS program may be completed by submission of an approved thesis or by other academic exercises (see requirements listed in the chapter on “Courses of Instruction”). In either case, a maximum of 6 units may be earned by the completion exercises and the final examination.

Thesis Requirements. The thesis should demonstrate the student’s ability to collect, arrange, interpret, and report pertinent material on a research problem. The thesis must be written in an acceptable style and should exhibit the student’s competence in scholarly procedures. Requirements of form are set forth in the Duke University Guide for the Preparation of the Master’s Thesis, which is available on the Duke University Graduate School Web site.

The thesis must be submitted in an approved form to the Graduate School prior to defense (see deadlines for submission and defense posted on the Graduate School Web site). The copies of the thesis will be distributed by the student to the several members of the examining committee. The original and one copy will be bound for the library upon payment of the university binding fee of $18. Beginning in the fall of 2010, master’s degree theses must be submitted in electronic format—paper format will no longer be acceptable.

The Examining Committee and the Examination. The program or department’s director of graduate studies recommends an examining committee composed of at least three members of the graduate faculty, one of whom is usually from a department other than the major department or from an approved minor area within the major department. The committee must be approved by the dean of the Graduate School before the student applies for graduation. A student must be registered in the term during which he or she takes the final examination.

Non-thesis examinations take several forms within the Graduate School. The most common are written or oral exams on a prescribed reading list or body of material; oral exams on a paper or a set of papers submitted by the student; or an oral exam on a research project or memorandum. The doctoral preliminary examination may also serve as the final examination for the master's degree.

The master's committee will conduct the examination and certify the student's success or failure by signing the card provided by the Graduate School office. Successful completion of the master’s examination requires at least three affirmative votes and no more than one negative vote. The sole exception to this policy is that a negative vote cast by the chair of the examining committee will mean a failure on the examination. The committee may extend to the student the privilege of taking the examination a second time in case of failure. If the student passes the examination, the card indicates completion of all requirements for the degree. If a thesis is presented, the committee members also sign the title page of the thesis, and the candidate then returns the original and one copy to the Perkins Library Circulation Desk. Electronic thesis submission will be required beginning with the fall 2010 term.

MASTER OF ARTS IN TEACHING

See “The Master of Arts in Teaching Program” on page 161 for a description of the MAT degree.
Additional Master’s Regulations

Filing the "Apply for Graduation" Form. On or before January 25 for a May degree, on or before July 1 for a September degree, on or before November 1 for a December degree, and at least one month prior to the final examination, students must file the "Apply for Graduation" form electronically by going to their student record online. The declaration of intention to graduate presents the title of the thesis or specifies alternative academic exercises on which the degree candidate will be examined. The "Apply for Graduation" form is not valid for more than one semester—a new form will need to be filed for completion of the degree in a subsequent term.

Transfer of Credits. A maximum of 6 units of graduate credit may be transferred for graduate courses completed at other schools. Such units will be transferred only if the student has received a grade of B (or its equivalent) or better. The transfer of graduate credit does not reduce the required minimum registration of 30 units for a master’s degree at Duke, even though it may relieve the student of coursework required by the major department. Requests for transfer should be submitted on the approved Graduate School form.

Nondegree Students. Credit for graduate courses taken at Duke by a student (not undergraduate) before degree admission to the Graduate School or while registered as a nondegree student through Duke Continuing Studies or the Graduate School may be carried over into a graduate degree program if (1) the action is recommended by the student’s director of graduate studies and approved by the dean, (2) the amount of such credit does not exceed 12 units, (3) the work has received grades of B or better, (4) the work is not more than two years old, and (5) the student applies for and is granted formal admission into a degree program.

Time Limits for Completion of Master’s Degrees. Master’s degree candidates who are in residence for consecutive academic years normally complete all requirements for the degree within two calendar years from the date of their first registration in the Graduate School. Candidates must complete all requirements within six calendar years of their first registration.

To be awarded a degree in May, the recording of transfer credit must be completed by the first day of the final examination period. If a thesis is one of the requirements, it must be submitted to the Graduate School office by the deadline posted on the Graduate School Web site. Candidates desiring to have their degrees conferred on September 1 must have completed all requirements, including the recording of transfer of credit, by the last weekday of the Duke University summer session. Candidates completing degree requirements after that date and during the fall will have their degrees conferred on December 30.

Degree Regulations—The Doctoral Degree

Requirements. The formal requirements for the PhD degree are as follows: (1) payment of 6 semesters of full-time tuition (or five if credit for previous graduate work has been approved), (2) major and related courses, (3) foreign language(s) in many departments, (4) training in the Responsible Conduct of Research, (5) a supervisory committee for the student’s program of study, (6) residence, (7) preliminary examination, (8) dissertation, (9) final examination, and (10) final dissertation submission to UMI/ProQuest.

Major and Related Work. The student’s program of study normally demands substantial concentration on courses in the major department, plus coursework in related minor fields as determined by individual programs. If there are deficiencies in a student’s undergraduate program, departments may also require certain undergraduate courses to be taken. In all cases the student’s director of graduate studies in consultation with the student’s supervisory committee will determine if the student must meet requirements above the minimum.

Foreign Languages. The Graduate School has no foreign language requirement for the PhD, but individual departments may have such requirements. For specific departmental language requirements, see the chapter on “Courses of Instruction” or contact the appropriate director of graduate studies.

English Language Proficiency. All international PhD students are subject to the requirement described on page 40 of this bulletin.

Responsible Conduct of Research. Beginning with the entering class of Fall 2003, all doctoral students at Duke University will be required to complete a series of training sessions in the Responsible Conduct of Research (RCR). These sessions will consist of two components: the first is an orientation workshop given at the beginning of each academic year for all new incoming students. All students in the Biomedical Sciences will attend the general introductory workshop at the Duke University Marine Laboratory; students in the Humanities and Social Sciences will attend a similar introductory workshop on the main campus, as will students in non-medical Biological Sciences, Physical Sciences and Engineering programs. All PhD students will subsequently attend a minimum number of RCR forums or other training experiences (including workshops and courses) scheduled throughout the academic year on individual topics related to responsible conduct of research. The number and content, as well as the annual schedule of,
such forums, courses or workshops will be published at the beginning of each fall semester on the Graduate School Web site. Students should complete their RCR training requirement by the end of their third year at Duke.

**Committee to Supervise the Program of Study.** As early as a student’s course of study as is practicable and not later than two months before the preliminary examination, the director of graduate studies in the major program or department will nominate for the approval of the dean a supervising committee consisting of at least four members, with one member designated as chair. This committee should include at least three graduate faculty members from the major department and, usually, at least one from outside the department. For programs in which approval has been granted for related work from a clearly differentiated division within the department, one member of the committee may be chosen from that division. This committee, with all members participating, will determine a program of study and administer the preliminary examination.

**Progress towards Degree.** All PhD students must file annually, beginning with their second year of study, a report to their director of graduate studies summarizing their progress towards the degree. For students who have passed the preliminary examination and are working on their dissertations, it is expected that this progress summary will also be given to their doctoral committees. Failure on the part of a student to submit an annual progress report will jeopardize the Graduate School’s ability to certify satisfactory progress towards the degree and thus both the student’s continuation in their graduate program and their eligibility for financial support.

**Residence.** The minimum residence requirement is one academic year of full-time registration at Duke (that is, two consecutive semesters of full-time tuition).

**Time Limits.** Ordinarily a student registered for full-time study should pass the preliminary examination by the end of the third year. A student who has not passed the examination by this time must file with the dean of the Graduate School a statement, approved by the director of graduate studies in the major department, explaining the delay and setting a date for the examination. Except under unusual circumstances, extensions will not be granted beyond the middle of the fourth year.

Ordinarily, credit is not allowed for graduate courses (including transfers) or foreign language examinations that are more than six years old at the date of the preliminary examination. Similarly, credit will not be allowed for a preliminary examination that is more than five years old at the date of the final examination. In cases of exceptional merit, however, the dean of the Graduate School may extend these limits. Should either of these limits be exceeded, the student’s department must submit to the dean specific requirements for revalidating credits or examinations. The doctoral dissertation should be submitted and accepted within two calendar years after the preliminary examination is passed. Should the dissertation not be submitted and accepted within four years after the examination, the candidate may, with the approval of the committee and the director of graduate studies, petition the dean of the Graduate School for an extension of up to one year. If this extension is granted and the dissertation is not submitted and accepted by the new deadline, the student may be withdrawn from candidacy. The student must then pass a second preliminary examination to be reinstated as a candidate for the degree. In such cases, the time limit for submitting the dissertation will be determined by the dean of the Graduate School and the candidate’s committee.

**Preliminary Examination.** A student is not accepted as a candidate for the PhD degree until the preliminary examination has been passed. The examination ordinarily covers both the major field and related work, although some departments or programs cover such field expertise in a separate qualifying examination. Please consult Courses Chapter or the degree program Web site for individual department or program procedures. In the summer a preliminary examination may be scheduled only between the opening and closing dates of the summer session. A student must be registered in the term during which he or she takes the preliminary examination.

Successful completion of the preliminary examination requires at least four affirmative votes and no more than one negative vote. The sole exception to this policy is that a negative vote cast by the chair of the examining committee will mean a failure on the examination. A student who fails the preliminary examination may apply, with the consent of the full supervisory committee and the dean of the Graduate School, for the privilege of a second examination to be taken no earlier than three months after the date of the first. Successful completion of the second examination requires the affirmative vote of all original committee members. Failure on the second examination will render a student ineligible to continue a program for the PhD degree at Duke University.

The qualifying and/or preliminary examination may also be used as the completion exercise for awarding a master’s degree either for a terminal master’s or, where appropriate, for awarding a master’s degree en route to the PhD.

**The Dissertation.** The dissertation is expected to be a mature and competent piece of writing, embodying the results of significant and original research. One month before the dissertation is presented and no later than January 25 preceding the May commencement, July 1 for a September degree, and November 1 for a December degree, the student must apply for graduation electronically. This application should indicate the approved title of the dissertation and be
approved by both the director of graduate studies of the student’s major department and the professor who directs the dissertation.

The basic requirements for preparing the dissertation are prescribed in the Guide for Electronic Preparation of Dissertations, which is available on the Graduate School Web site. The dissertation must be completed to the satisfaction of the professor who directs the dissertation, members of the student’s advisory committee, and the dean of the Graduate School. An electronic copy of the dissertation must be uploaded to UMI/Proquest for review and approval by the Graduate School at least one week prior to the defense. Deadlines for dissertation submission are posted on the Graduate School Web site and must be respected if the student wishes to receive the degree in the semester when the intention to graduate had been declared. All doctoral dissertations are submitted electronically to UMI/ProQuest in Ann Arbor, Michigan and to DukeSpace in the Duke Libraries, where they are openly accessible online. See the Graduate School Web site for information about electronic submission and about procedures for obtaining a copyright. Abstracts are published in Dissertation Abstracts International. A nonrefundable archiving fee of $65 is charged when the student submits the dissertation electronically to UMI/ProQuest.

Final Examination. The final examination is administered by a supervising committee of at least four members, who must have at least two weeks to read and review the completed dissertation before the final examination. The final oral examination shall be primarily on the dissertation; however, questions may be asked in the candidate’s major field. Except in unusual circumstances approved by the dean, a final examination will not be scheduled when the university is not in session. A student must be registered during the term when he/she takes the final examination.

Successful completion of the final examination requires at least four affirmative votes and no more than one negative vote. The sole exception to this policy is that a negative vote cast by the chair of the examining committee will mean a failure on the examination. A student who fails the final examination may be allowed to take it a second time, but no earlier than six months from the date of the first examination. Permission to take the second examination must be obtained from the professor who directed the dissertation and the other examining committee members, as well as from the dean of the Graduate School. The second examination must be administered by the same committee, and a second failure renders the student ineligible to continue work for the PhD degree at Duke University.

Deposit of the Dissertation. After passing the examination, candidates upload the final electronic version of the dissertation to ProQuest and DukeSpace. A student must be registered during the term when he or she submits the final version of the dissertation.

Commencement

Graduation exercises are held once a year, in May, when degrees are conferred and diplomas are issued to those students who have completed requirements by the end of the spring. The May commencement also includes a hooding ceremony. Those who complete degree requirements by the end of the fall or by the end of a summer term receive diplomas dated December 30 or September 1, respectively. There is a delay in the mailing of September and December diplomas because diplomas cannot be issued until they are approved by the Academic Council and the Board of Trustees.

The Duke Community Standard

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

• I will not lie, cheat, or steal in my academic endeavors;
• I will conduct myself honorably in all my endeavors; and
• I will act if the Standard is compromised.

Standards of Conduct

Graduate students at Duke University freely choose to join a community of scholarship predicated on the open exchange of ideas and original research. At Duke University, students assume the responsibility to foster intellectual honesty, tolerance, and generosity and to encourage respectful debate and creative research. By accepting admission to Duke University, graduate students pledge to uphold the intellectual and ethical standards of the University, as expressed in the Duke Community Standard, to respect the rights of their colleagues, to abide by University regulations, and to obey local, state, and federal laws. The Graduate School and the University specifically prohibit the following:

1. Lying: Knowing misrepresentations to gain illicit benefit or to cause harm to others. Examples include misrepresentation in applications for admissions or financial aid, lying during a formal inquiry by the
2. **Cheating:** A dishonest or unfair action to advantage an individual’s academic work or research. Such dishonesty would include the falsification of data, plagiarism, and tampering with another person’s documents or research materials.

3. **Theft:** Misappropriation of property, services, credentials, or documents. Theft includes the misuse or willful damage of University property, equipment, services, funds, library materials, or electronic networks.

4. **Harassment:** The creation of a hostile, intimidating, disrespectful environment based on race, religion, gender, ethnicity, or sexual orientation, in which verbal or physical conduct, because of its severity or persistence, is likely to interfere significantly with an individual’s work or education, or affect adversely an individual’s living conditions. Duke University is committed to protecting academic freedom for all members of the university community. This policy against harassment is, therefore, applied so as to protect the rights of all parties to a complaint. Academic freedom and freedom of expression include but are not limited to the expression of ideas, however controversial, in the classroom, residence hall, and, in keeping with different responsibilities, in workplaces elsewhere in the university community.

5. **Sexual harassment:** Coercion through speech or action for sexual purposes. Examples include verbal or written threats, unwanted sexual solicitation, stalking, and the use of a position of authority to intimidate or coerce others. Duke teaching personnel, employees, and graduate students are expected to report consensual sexual relationships between individuals in a supervisory or teaching relationship to their superiors. Examples of such supervisory/teaching relationships include: instructor and student; advisor and student; and supervisor and staff member.

6. **Assault:** An attack on another person resulting in either physical or psychological injury.

7. **Possession of illicit drugs on University property or as part of any University activity:** Students are prohibited to manufacture, sell, deliver, possess, or use a controlled substance without legal authorization. The North Carolina Controlled Substances Act defines a controlled substance as any drug, substance or immediate precursor, including but not limited to opiates, barbiturates, amphetamines, marijuana, and hallucinogens. Possession of drug paraphernalia is also prohibited under North Carolina law and University policy. Drug paraphernalia includes all equipment, products and material of any kind that are used to facilitate, or intended or designed to facilitate, violations of the North Carolina Controlled Substances Act.

8. **Refusal to comply with the directions of a University police officer:** Students must comply with the lawful directions of the University police. In addition, interference with the proper operation of safety or security devices, including emergency telephones, door locks, fire alarms, smoke detectors or any other safety device is prohibited.

9. **Trespassing:** Students may not enter University property to which access is prohibited.

10. **Possession of explosives, incendiary devices, or firearms on University property:** Students are expected to meet academic requirements and financial obligations, as specified elsewhere in this bulletin, in order to remain in good standing. Failure to meet these requirements and to abide by the rules and regulations of Duke University may result in summary dismissal by the Dean of the Graduate School or the Provost. In accepting admission, students indicate their willingness to subscribe to and be governed by these rules and regulations and acknowledge the right of the university to take disciplinary action, including suspension and/or expulsion, as may be deemed appropriate for failure to abide by such rules and regulations or for conduct adjudged unsatisfactory or detrimental to the university.

**STUDENT GRIEVANCE PROCEDURES.** It is the responsibility of the director of graduate studies to inform each graduate student of the appropriate channels of appeal. In normal circumstances, the director of graduate studies is the first to hear a complaint. If the complaint cannot be resolved satisfactorily at this level, the student may address, in turn, the department chair, the associate dean of the Graduate School, and the dean of the Graduate School, who shall be the final avenue of appeal. An appeal must be filed in writing with the next appropriate university officer within ten days after a decision has been formally rendered by any of the university officers mentioned above.

**JUDICIAL CODE AND PROCEDURES.** In the spring of 1971, the Graduate School community ratified and adopted an official judicial code and procedures. These procedures were subsequently amended in November, 1998, and in May, 2007.

**I. Graduate School Judicial Code and Procedures**

A. A student, by accepting admission to the Graduate School of Duke University, thereby indicates willingness to subscribe to and be governed by the rules and regulations of the University as currently are in effect or, from time to time, are put into effect by the appropriate authorities of the University, and indicates willingness to accept disciplinary action, if behavior is adjudged to be in violation of those rules or in
II. The Graduate School Judicial Board

A. Composition. The Graduate School Judicial Board shall have five members, serving for a period of two years: two graduate students appointed from the student body by the dean of the Graduate School with the advice of the Graduate and Professional Student Council, two members of the graduate faculty appointed by the Executive Committee of the Graduate Faculty, and one associate or assistant dean appointed by the dean of the Graduate School. The Board shall elect one of its members as chairman. The Board shall have at its service a recording secretary to keep minutes of the hearings and of the Board’s actions in a permanent, confidential record book. The Board will be constituted in order to hear cases in which the accused is a student currently enrolled in the Graduate School and in cases in which the accused is a former student but which arise out of activities of the accused while a student enrolled in the Graduate School, and which have been referred to it by the director of graduate studies or members of the faculty in the major department.

B. Preliminary Procedures. If a student requests a hearing by the Judicial Board it must be done in writing, allowing its chairman at least seventy-two hours to convene the Board. In addition, the chairman shall not convene the Board until seventy-two hours after being asked to convene the Board. It is the responsibility of the chairman of the Judicial Board fully to inform its members concerning the case and the reasons the case has been referred to the Board; and to prepare a written summary of this information for the Board, the dean, and the student.

C. Procedural Safeguards for the Hearing. The accused has the right to challenge any member of the Judicial Board on grounds of prejudice. If the Board decides to excuse one or more of its members for reasons given by the accused, it shall consult with the dean about the need for replacements. The accused may choose an advisor to assist in the hearing. The advisor must be a current Duke student, a current Duke faculty member, or a current Duke employee. The role of the advisor is to assist and support the student through the disciplinary process. The advisor may not address the hearing panel or any witness during the hearing. The accused may also produce witnesses (including no more than two character witnesses), introduce documents, and offer testimony. A person having direct knowledge relevant to a case being heard by the Board is a material witness. The Judicial Board may request the appearance of material witnesses. The Board shall also request, upon written request of the complainant or the accused, the appearance of material witnesses. Witnesses shall be notified of the time, place, and purpose of their appearance. The accused has the right to examine the written statement of any witness relevant to the case at least seventy-two hours before the hearing. The accused has the right to be faced with any witness who has given a statement relevant to the case at the hearing if the witness’s attendance can be secured. The hearing will be conducted in private unless the accused requests an open hearing. If any objection is raised to conducting an open hearing in any particular case, the Judicial Board shall decide the issue by majority vote. If the decision is made not to hold an open hearing, the accused shall be informed in writing of the reasons for the decision. The Judicial Board shall consider only the report of the chairman, documents submitted into evidence, and the testimony of witnesses at the hearing in reaching its decisions.

D. Conduct of the Hearing. The hearing of any case shall begin with a reading of the charge by the chairman in the presence of the accused. The accused shall then plead guilty or not guilty or move to terminate or
postpone the hearing. The accused may qualify a plea, admitting guilt in part and denying it in part. The accused may not be questioned for more than one hour without recess. At any time during the hearing, the accused or the Judicial Board may move to terminate or to postpone the hearing or to qualify the plea or to modify its charge.

Pending verdict on charges (including appeal) against the accused, status as a student shall not be changed, nor the right to be on campus or to attend classes suspended, except that the provost may impose an interim suspension upon any member of the University community who demonstrates, by conduct, that continued presence on the campus constitutes an immediate threat to the physical well-being or property of members of the University community or the property or orderly functioning of the University.

E. Appeals. The appellant may submit to the dean a written statement containing the grounds for appeal and arguments. In such cases, the dean should determine if the appeal should be granted, and the dean can hear the case, or refer it to the appropriate faculty in the student’s department or to the Judicial Board.

F. Sanctions and the Verdict. The Graduate School Judicial Board shall have the power to impose the following penalties: expulsion (dismissal from the University with the recommendation that the person never be readmitted); suspension (dismissal from the University and from participation in all University activities for a specified period of time, after which the student may apply for readmission); disciplinary probation (placing the student on a probationary status for a specified period of time, during which conviction for violation of any regulation may result in more serious disciplinary action); restitution (payment for all, or a portion of property damage caused during the commission of an offense). Restitution may be imposed by itself or in addition to any of the other penalties. In the case of a student who is not currently at Duke or who has already graduated, such sanctions could include revocation of the degree.

The Judgment shall consist of a finding of guilty or not guilty of the charge and, when the accused is found guilty, a statement of the punishment assessed. On all questions, including the verdict and the finding of guilty or not guilty, the Board shall be governed by a majority vote. The Judicial Board may decide to rehear a case in which significant new evidence can be introduced. In addition, the defendant may request an appeal. An appeal shall be granted on the following grounds: procedural error substantially affecting the rights of the accused; incompatibility of the verdict with the evidence; excessive penalty not in accord with “current community standards;” new evidence of a character directly to affect the judgment but on which the original tribunal had refused a new hearing.

III. Amendment and Construction

This Judicial code and procedure and this constitution and procedure for the Graduate School Judicial Board may be amended at any time with due notice or publication by consent of the dean, the Executive Committee of the Graduate Faculty, and the graduate student representatives of the Graduate and Professional Student Council. Questions and problems not answered or anticipated by the foregoing may be resolved by the use of other existing institutions or by amendment.
Departments, Programs, and Course Offerings

Course Enrollment

Courses numbered 200-299 are sometimes open to qualified undergraduate students who have received permission of the instructor and the director of graduate studies.

Undergraduate students are not permitted in any courses above 300. Double numbers separated by a hyphen indicate that credit is contingent upon completion of both courses. Double numbers separated by a comma indicate that although the course is a year-long course, credit may be received for either course or both courses.

The following symbols, suffixed to course numbers, identify the small group learning experiences: S, seminar; P, preceptorial; T, tutorial; D, discussion section. The L suffix indicates that the course includes laboratory experience. C-L: denotes a course that is cross-listed or a program under which a course is listed.

Certificate Programs

The Graduate School offers over 35 certificate programs (most of which are interdisciplinary or multidisciplinary) that draw upon the unique strengths of Duke's research institutes and faculty. Certificate programs are designed to provide graduate students with advanced training in interdisciplinary or emerging fields of knowledge by taking advantage of the distinctive resources available at Duke or in the Research Triangle Park area.

The certificate is a formal statement of the interdisciplinary coursework a student has completed, and it has proved to be a useful professional credential to students seeking positions after graduation. The student's official Duke University transcript notes the awarding of the certificate. (Additional information for each certificate program is available on the certificate’s Web page.)

Further descriptions, information, and requirements for all certificate programs are to be found in this chapter; see “DEPARTMENTS, PROGRAMS, AND COURSE OFFERINGS” on page 54 or use the below links to navigate to individual certificate program listings.

- Advanced Quantitative Methods in the Social Sciences
- African and African American Studies
- Anthropology and History
- Biological and Biologically Inspired Materials
- Biomolecular and Tissue Engineering
- Canadian Studies
- Cell and Molecular Biology
- Cognitive Neuroscience
- Computational Biology and Bioinformatics
- Computational Science, Engineering, and Medicine
- Developmental Psychology
- Developmental and Stem Cell Biology
- East Asian Studies
- Ecology
- Education Policy Research
- Genetics and Genomics
- Global Health
- Health Policy
- History and Philosophy of Science, Technology, and Medicine
Advanced Quantitative Methods in the Social Sciences

Professor Aldrich, Director of Graduate Studies

A certificate is available in this program.

The central mission of the graduate certificate in Advanced Quantitative Methods in the Social Sciences is to provide interested doctoral students with a coherent and integrated understanding of quantitative approaches in the social sciences. The program is intended for doctoral students from any department or school who have interests in research in the social sciences. The goal is to provide advanced training in quantitative methods in an interdisciplinary context to facilitate research without regard to discipline and communication across disciplinary boundaries. Applications are typically made late in the second year or in the third year.

Requirements:

• Four graduate level, interdisciplinary courses in social sciences.

  1) Mathematics and Mathematical Statistics: All candidates must demonstrate competence in basic mathematics, equivalent to completion of a basic course or series of courses in multivariate calculus, linear algebra, and probability theory through Statistics 213 or Economics 341.

  2) Research Design: All candidates must have the equivalent of a course in the fundamental principles of research design, typically acquired through training within the home department, such as Political Science 310 or 330, Psychology 318, or Sociology 208 and 302.

  3) Formal Modeling and Derivation of Hypotheses: All candidates must achieve competence in formal modeling. The expectation is that the student will have training at least at the equivalent of a microeconomics course in economics. The most preferred course is Economics 302 depending on the applicant's objectives (e.g., POL 243, PSY 349/350, SOC 302, or BUS 513).

  4) Hypothesis Testing: All candidates must achieve competence in the testing of hypotheses. This can be satisfied by successful completion of Statistics 214 or 290. In addition, applicants may ask that the board accept a disciplinary equivalent (currently taught examples include Economics 342, POL 233, PSY 274, and SOC 213).

• Advanced, Interdisciplinary Knowledge: a minimum of two courses – the equivalent of a year-long training – in one or more advanced, interdisciplinary topics of special interest to the student (all courses being outside the individual’s own department and ordinarily unavailable within it), plus the PARISS capstone course.
African and African American Studies

For additional information visit the program’s Web site, http://www.ssri.duke.edu/.

African and African American Studies

Professor Piot, Interim Director (141 Franklin Center); Associate Professor Crichlow, Director of Graduate Studies (139 Franklin Center); Professors H. Baker, Gaspar, Holloway, James, McClain, Payne, and Powell; Associate Professors L. Baker, Crichlow, Lubiano, Neal, and Piot; Assistant Professors Glymph, Holsey, and Makhulu

A certificate is available in this program.

The African and African American Studies Program (AAASP) offers a certificate in African and African American studies. Students enrolled in doctoral programs and in the Master of Arts in Liberal Studies (MALS) program are eligible and may work concurrently with their departments to satisfy the requirements for a certificate in African and African American studies. The curricular format is a trifold course of study that includes coursework, teaching, and research. The award of a graduate certificate is carried on the student’s official transcript upon completion of the program. Students enrolled in the graduate program are eligible to apply for AAASP-sponsored teaching assistantships for undergraduate courses.

Graduate study leading to the certificate in African and African American studies encourages research and scholarship in all dimensions of the African and African American experience. The graduate program is designed to provide access for students and scholars to a broad range of information and research from the humanities and social sciences, and the arts and professions, while taking advantage of the university’s distinctive resources in each of these areas of study. Approximately 75 faculty in nearly 34 university departments and programs participate in AAASP and are available to mentor graduate students. Graduate students enrolled in the program are encouraged to participate in all African and African American Studies Program events, and to audit the lecture series and symposia.

A brochure is available upon request giving detailed information about requirements for the graduate certificate. For further information regarding application and enrollment in the graduate certificate program in African and African American studies, contact the program’s director of graduate studies or visit http://aaas.duke.edu/.

Requirements:

• Must take core graduate seminar African and African American Studies 297: Teaching Race, Teaching Gender.
• Must take two additional courses that originate in, or are cross-listed with African and African American Studies.
• Must take a fourth course and submit a course proposal with syllabus for a potential African and African American Studies undergraduate course; or teach an African and African American Studies undergraduate course. The director of graduate studies must approve the fourth course and the course proposal or the teaching experience as appropriate for the certificate.
• Write a dissertation in an African and African American Studies area with core or affiliated faculty represented on the dissertation committee.

African and African American Studies Courses (AAAS)

200S. Seminar in Asian and Middle Eastern Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 200S; also C-L: Cultural Anthropology 288S, Literature 200S
209S. Race, Class, and Gender: A Social History of Modern (1750-present) Britain. 3 units. C-L: see History 209S
210S. Black Visual Theory. 3 units. C-L: see Visual Studies 221S
213S. African Modernities. Encounters between African societies and global forces, including colonialism, capitalism, development initiatives. Instructor: Holsey. 3 units. C-L: Cultural Anthropology 203S
217S. Schooling and Social Stratification. 3 units. C-L: see Public Policy Studies 217S; also C-L: Education 217S
225S. Monuments and Memory: Public Policy and Remembrance of Racial Histories. 3 units. C-L: see Public Policy Studies 225S
229S. Poverty, Inequality, and Health. 3 units. C-L: Public Policy Studies 229S
254. Justice, Law, and Commerce in Islam. 3 units. C-L: see Religion 254; also C-L: Medieval and Renaissance Studies 254
262S. Minority Mental Health: Issues in Theory, Treatment, and Research (P). 3 units. C-L: see Psychology 262S
268S. Harlem Renaissance. 3 units. C-L: see Art History 269S
270S. Topics in African Art. 3 units. C-L: see Art History 270S
278S. Race and American Politics (A). 3 units. C-L: see Political Science 278S; also C-L: Public Policy Studies 278S
279S. Race, Racism, and Democracy. 3 units. C-L: see Cultural Anthropology 279S
293. Special Topics in Literature and History. Instructor: Staff. 3 units.
297S. Teaching Race, Teaching Gender. Interdisciplinary analyses of the problematic of teaching about social hierarchies, especially those of race, class, and gender. Curricular content and its interaction with the social constructions of students and
Anthropology and History

Professor Reddy, Co-Director of Graduate Studies; Professor Silverblatt, Co-Director of Graduate Studies

A certificate is available in this program.

For several decades, historians have been turning to cultural anthropology, and anthropologists to history, for methodological guidance. By now a relatively large number of historians and anthropologists work within a shared framework, asking similar questions, and seeking answers to these questions from similar kinds of evidence. In both disciplines it is widely understood that cultural diversity and cultural change cannot be accounted for either by the traditional narrative techniques of historians or by the traditional ethnographic descriptions of anthropologists. Instead, historians realize they must look beyond action, intention, and event, to underlying patterns, unspoken presuppositions, institutional and discursive structures. Anthropologists realize that kinship, ritual, social role, discourse, and belief are all subject to improvisation, contestation, politicization, and thus to change. Scholars in both disciplines have looked to practice theory, as developed by Bourdieu, Giddens, Ortner, and Sewell; to postcolonial studies, as developed by Stoler, Dirks, Spivak, Das, and Burton; to performance theory, as developed by Sahlins, Butler, Sedgwick; and to other, related approaches.

Drawing on these streams of theory, anthropologists and historians strive to come to grips with the full implications of cultural diversity and change. The challenge is to understand what all actors in a given context consciously know and intend as well as what they unconsciously take for granted, what they do on purpose and what they do without reflection, and to see how action and conflict have both intended and unintended consequences. One goal of such research is a new kind of total history, of the kind the Comaroffs have attempted for South Africa. Another goal is the recovery of forgotten or suppressed pathways to meaning of the kind rescued from oblivion by recent work on indigenous sexuality in colonial Mexico or Spanish judicial repression in colonial Peru. Still another is the exploration of historical change in “affect,” the seemingly automatic responses to situations that often encode cultural assumptions and set the parameters of meaning and action. Still another is the extention of ethnographic understandings to the materials of Western history, and the history of anthropology itself.

Collaboration between faculty of the History and Cultural Anthropology departments at Duke has been active since the 1980s. Numerous crosslisted graduate seminars and joint work on graduate preliminary examination committees and dissertation defense committees have testified to the vital role of this collaboration for graduate training over the years.

We have now formalized this collaboration with a certificate program to ensure that students who wish to draw on the other discipline gain familiarity with the joint methods of both disciplines in a more systematic way. Students will also receive a tangible token in recognition of their accomplishments.

Students enrolled in the PhD programs of either Cultural Anthropology or History wishing to earn a certificate in Anthropology and History must designate a mentor from among the affiliated faculty of the certificate program. With their mentors, students will draw up a coherent program of study leading to the certificate.

Requirements:

• Student must designate a mentor from the affiliated faculty of the certificate program.
• With mentor, student must draw up a program of study that must include:
  1) Completion of a core graduate seminar:
      a) Beginning with a two-semester sequence beginning with HST 210S/CA 207S: Anthropology and History.
      b) Concluding with a research seminar in which students prepare and present their own papers.
  2) Participation (while in residence) in an Anthropology and History colloquium to be organized by the affiliated faculty and the students.
  3) One presentation of the student’s own work at the colloquium, usually during the writing phase of the dissertation.
  4) At least two other courses in the non-degree department.
  5) Capstone research paper (if in History, this may be a part of the student’s portfolio).
  6) Preliminary examination field in the non-degree discipline.
The director of graduate studies in each department, assisted by one member of the affiliated faculty from each department (initially William Reddy and Irene Silverblatt) will monitor the student’s progress and review his/her dossier at least once annually.

PhD students in other Duke departments and programs may also earn a Certificate in Anthropology and History; for details, see www.duke.edu/~wmr/anthandhist.htm.

Art, Art History and Visual Studies

Professor Van Miegroet, Chair (115B East Duke Building); Associate Professor Weisenfeld, Director of Graduate Studies (116A East Duke); Professors Antliff, Bruzelius, Leighten, McWilliam, D. Morgan, Powell, Seaman, Stiles, Wharton; Associate Professors Abe, Dillon, Gabara, and Weisenfeld; Assistant Professor Galletti

A PhD is available in this department.

The Department of Art, Art History, and Visual Studies offers graduate work leading to the PhD degree in art history. The doctoral program in the history of art is competitive with the leading art history programs in the country. We are committed to full and equal funding of our students during their time in residence at Duke. Admission to the program is limited to between four and six new students per year.

The PhD program in the history of art is integrally connected with many interdisciplinary, theoretical, and international initiatives in the humanities at Duke. The doctoral program is distinguished by its flexibility and cross-disciplinarity. It requires a thorough grounding in the form and meaning of objects and sites, as well as in their theoretical and historical contexts. Course work has been designed to prepare students for careers in art and architectural criticism, research and teaching in the academy, museum, and art gallery. Faculty in the program are expert in a broad range of areas of art history, as well as in a variety of media, from architecture, sculpture and painting to video and cybernetics.

Students are required to demonstrate their ability to read those languages necessary to their research fields as determined by their faculty advisors; exams must be passed in at least two foreign languages before taking the preliminary examinations.

For further information on the PhD Program, prospective applicants may look at the Department's Web site: http://www.duke.edu/web/art/, or write to the director of graduate studies.

The department also participates in a program with the Law School leading to a joint JD/MA degree. The Guidelines for Graduate Students in the Doctoral Program in Art History and the Guidelines for Graduate Students in the JD/MA Program fully describe these and additional requirements and the detailed steps in the student’s graduate career.

For information on the JD/MA Program please contact the departmental Web site at: http://www.duke.edu/web/art/announce/JDMAinAH.pdf or send e-mail to DeptAAH@duke.edu for further information.

Art History Courses (ARTHIST)

200S. Special Topics. Focus on particular aspects of Art and Art History. Topics vary. Instructor consent required. Topics course. Instructor: Staff. 3 units.

201S. Greek Art and Society: Archaic To Classical. Main categories of buildings, monuments, and images most characteristic of ancient city life in fifth and fourth centuries BCE. Range of material studied: city plans, temples, statues, reliefs, painted pottery. Emphasis on archaeological and historical contexts; questions and themes concern relation of new forms of public building and representation to changing historical circumstances. Fifth century made decisive break with archaic visual modes; area of special investigation is swift emergence and consolidation of revolutionary way of seeing and representing known as 'classical art'. Instructor: Dillon. 3 units. C-L: Classical Studies 220S

204S. Greek Art and Society: Hellenistic. Greek world expanded by Alexander's conquests into western Anatolia and north-western India. Material and visual culture of important sites and characteristic buildings, monuments, images. Particular attention paid to: recent discoveries at Vergina and Pella; royal capital of Attalid Pergamon; city-states of Athens and Priene; Egyptian and Greek interaction in Ptolemaic Alexandria and Egypt. Other important subjects include: the Hellenistic royal image on coins and in statues; colonial settlement, such as that at Ai Khanoum in north-east Afghanistan; changes in honorific and funerary representation. Course also looks at late Hellenistic Delos and mass export of Hellenistic material. Instructor consent required. Instructor: Dillon. 3 units. C-L: Classical Studies 240

210S. Renaissance Studies. 3 units. C-L: see Italian 210S; also C-L: Medieval and Renaissance Studies 210S

227S. Roman Painting. 3 units. C-L: see Classical Studies 236S

236S. Topics in Romanesque and Gothic Art and Architecture. Analysis of an individual topic. Subject varies from year to year. Consent of instructor required. Instructor: Bruzelius. 3 units. C-L: Medieval and Renaissance Studies 237S

237S. Greek Painting. 3 units. C-L: see Classical Studies 232S

238S. Greek Sculpture. 3 units. C-L: see Classical Studies 231S

240S. Technology and New Media: Academic Practice. 3 units. C-L: see Information Science and Information Studies 240S; also C-L: Visual Studies 250BS
241. History of Netherlandish Art and Visual Culture in a European Context. A contextual study of visual culture in the Greater Netherlands and its underlying historical and socioeconomic assumptions from the late medieval to early modern period, through immediate contact with urban cultures, such as Amsterdam, Leiden, Utrecht, Brussels, Ghent, Bruges, and Antwerp. Includes daily visits to major museums, buildings, and sites; hands-on research in various collections; discussion sessions with students who have taken Art History 158-159. Course credit contingent upon completion of Art History 242. Instructor: Van Miegroet. 3 units. C-L: Medieval and Renaissance Studies 241, Visual Studies 210


244. Soviet Art after Stalin 1956-1991. 3 units. C-L: see Russian 242S


247S. Topics in Italian Renaissance Art. Topics in art and/or architecture from c. 1300 to c. 1600. Subject varies from year to year. Consent of instructor required. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 248S

250S. Critical Studies in New Media. 3 units. C-L: see Information Science and Information Studies 250S; also C-L: Literature 261S, Visual Studies 250AS

255S. Museum Theory and Practice. Museum theory and the operation of museums, especially art museums, and how the gap between theory and practice is negotiated in the real world setting. Issues involving collecting practices, exhibition practices, and didactic techniques, as well as legal and ethical issues. Taught in the Nasher Museum. Instructor: Rorschach. 3 units.

263. Art & Dissidence: Films of Tarkovsky, Kubrick, Kurosawa, & Lynch. 3 units. C-L: Russian 263

265S. Topics in Nineteenth-Century Art. Focus on a major artist, movement, or trend in nineteenth-century art. Subject varies from year to year. Consent of instructor required. Instructor: Antliff, Leighten, or McWilliam. 3 units.

269S. Harlem Renaissance. The art and culture that was produced by and about African Americans (largely in the western metropoles) during the period roughly between the two world wars. Chronological overview, a focus on individual figures, and study of the criticism and creative writings of this period. Other topics include black migrations to urban centers, performance-as-a-visual-paradigm, racial and cultural primitivism, and an alternative, African American stream of early twentieth century visual modernism. Not open to students who have previously taken this course as Visual Studies 220S. Instructor: Powell. 3 units. C-L: African and African American Studies 268S

270S. Topics in African Art. Specific problems of iconography, style, connoisseurship, or a particular art tradition in African art. Subject varies from year to year. Consent of instructor required. Instructor: Powell. 3 units. C-L: African and African American Studies 270S

272S. Topics in Chinese Art. Problems and issues in a specific period or genre of Chinese art. Specific focus varies from year to year. Instructor: Abe. 3 units.

274S. Topics in Japanese Art. Problems and issues in a specific period or genre of Japanese art. Specific focus varies from year to year. Consent of instructor required. Instructor: Weisenfeld. 3 units.

283S. Topics in Modern Art. Selected themes in modern art before 1945, with emphasis on major movements or masters. Subject varies from year to year. Consent of instructor required. Instructor: Antliff, Leighten, or Stiles. 3 units.


288S. Special Topics. Subjects, areas, or themes that embrace a range of disciplines or art historical areas. Instructor: Staff. 3 units.

296S. Methodology of Art History. Various theoretical perspectives that have shaped different disciplinary perspectives and practices in art history. Introduction to particular types of methodologies (i.e. Marxism, feminism, race and gender, psychoanalysis, post-colonial theory, and deconstruction) as fields of inquiry through which the study of the visual arts and culture have been practiced. Historiography of the last two decades in art history; selected contemporary debates. Instructor: Staff. 3 units.

297S. Topics in Art since 1945. Historical and critical principles applied to present-day artists and/or movements in all media since World War II. Consent of instructor required. Instructor: Stiles. 3 units.

For Graduate Students Only

301. Museum Studies. Introduction to the organization and functions of the museum in preparation for the presentation of a student-organized exhibition. Most of the semester spent in independent study researching scholarly, critical essays for the catalog. Instructor: Museum Staff. 3 units.
302. Museum Studies. Completion of research and preparation of the catalog. Students actively participate in catalog design and production, and will be responsible for planning and installing the exhibition as well as interpreting it to the public through lectures and tours. Instructor: Museum Staff. 3 units.

303. Critical Approaches to Exhibitions and Museums. The historical context and critical analysis of exhibition theory and practices from curiosity cabinets to ethnological museums to postmodern spectacles with special attention to the development of the fine art museum as a distinctive site of visual display and consumption. Instructor: Abe. 3 units.

340. Goya and David: Enlightenment and Unreason. A comparative study exploring the artists' contrasting responses to contemporary currents in art, philosophy and politics; examination of Goya and David as historiographical subjects; exploration and critique of biographical strategies in art history. Instructor: McWilliam. 3 units.

341. Nationalism and Visual Culture Since 1789. Theories of nationalism, national identity and nationhood; cultural expression as a medium for nationalism; historical study of nationalist theories from Taine to the present day. Art history and national essentialism. National myths and the representation of heroes; the representation of the military; national enemies and subject peoples. National symbols and popular culture; the invention of national traditions; historicism and the visual construction of collective identities. Regionalism, folk art and the cult of the land; the representation of place in conceptions of nationhood. Nostalgia, from "Merrie England" to the Wild West. Nations covered include Britain, France, Germany & America. Instructor: McWilliam. 3 units.

350. Topics in Japanese Art. Problems and issues in a specific period or genre of Japanese Art. Specific focus varies from year to year. Consent of instructor required. Instructor: Weisenfeld. 3 units.

355. Death and Burial in the Middle Ages: The Impact on Architecture and Sculpture. Course will study attitudes towards the dead body and the fate of the soul in the middle ages, and the impact of changing approaches to burial on architecture and planning in the medieval city. Instructor: Bruzelius. 3 units.

364. Primitivism, Art, and Culture. Seminar studies issues of primitivism in western culture, considering attitudes towards race and gender. Particular attention to the function of primitivism within modernist discourse—especially as regards such major figures as Gauguin, Matisse, and Picasso; and critical evaluations of the concept of primitivism in the fields of anthropology, literary criticism, cultural geography, and social history. Consent of instructor required. Instructor: Leighten. 3 units.

366. British Modernism in the Early Twentieth Century. A seminar focusing on the development of modernism in England, from the creation of a British fauvist movement in 1910 to the advent of vorticism during World War I. Topics include Roger Fry and the Omega Workshops, J. D. Ferguson and the British fauvis, the vorticism of Wyndham Lewis, Jacob Epstein and Henri Gaudier-Brzeska, and the criticism of vorticists T. E. Hulme and Ezra Pound. These movements studied in the light of political ideology, literary theory, and gender studies. Consent of instructor required. Instructor: Antliff. 3 units.

367. Cubism and Cultural Politics. Seminar studies the cubist movement in pre-World War I Paris, considering art theory and production within the matrix of cultural politics and current critical debates in the field. Focus on significant figures including Georges Braque, Robert and Sonia Delaunay, Marcel Duchamp, Raymond Duchamp-Villon, Albert Gleizes, Juan Gris, Marie Laurencin, Henri Le Fauconnier, Fernand Léger, Jean Metzinger, Pablo Picasso, and others. Consent of instructor required. Instructor: Antliff or Leighten. 3 units.

369. Modernism and Cultural Politics. Issues of politics and art of the modernist period in Europe, focusing on movements significantly involved with and influenced by political thought and activism—from anarchism and Marxism to nationalism, neo-catholicism, royalism, and fascism—and/or subject to recent politicized art historical interpretation. Topics may include the neo-impressionism; symbolism; catalanism and the early Picasso; fauvism; primitivism; cubism; futurism; purism; the Bauhaus; deStijl; Russian avant-gardism; dada; and surrealism. Consent of instructor required. Instructor: Leighten. 3 units.

370. Art of the Courts in Thirteenth- and Fourteenth-Century Europe. Examination of the major courts of Europe in France, England, Germany, and Italy to study the development of court culture and the relationships and exchanges between the different courts through marriage alliances, exchanges of presents, and shifts in taste and style. Focus on the courts of Louis IX in France, Henry III and Edward II in England, and the court of Naples from 1266 onwards. Topics include patterns of spirituality, family relationships, and the role of women and books. Instructor: Bruzelius. 3 units.

373. The Paris Salon; Artists, Critics, and Institutions 1815-1900. Approaches the major exhibition of contemporary French painting and sculpture from multiple perspectives, highlighting involvement of successive political regimes in regulating the artistic economy. Analysis of artists' relationship with-and attempts to modify-the Salon structure, the emergence of alternative exhibiting venues, and the growth of the commercial art market. Particular emphasis on contemporary critical responses to artworks, viewed in the light of wider changes in journalism and the literary market place. Crucial texts and controversies over particular works will be examined in depth. The implications of reception theory for art history will be explored. Instructor: McWilliam. 3 units.

374. Jerusalem. Seminar assesses the contribution of Jerusalem's buildings to its contentiousness from Biblical to modern times. Particular sites (Me'a She'rim, the Dome of the Rock, the Holy Sepulchre, the Kotel or Wailing Wall, the souk, the Israeli Supreme Court, the Museum of the Seam, the Fence, etc.) considered in the context of the urban history of the city from the time of Jesus through Arab, Crusader, Turkish and British rule to contemporary Israeli control. How these places act upon the religious imagination and how they affect the ideological positions of their users (and their abusers) discussed on the basis of photographs, archaeological reports, news reports, novels, sacred texts and diaries. Instructor: Wharton. 3 units.
378. Outsiders and Insiders. An exploration of the phenomenon in Europe and the Americas during the nineteenth and twentieth centuries, when critics began to differentiate between art from learned, civilized communities and art from an uneducated, barbaric population. From the Beaux-Arts and Völkerkunde, to the debates surrounding primitivism, modernism, and popular culture. An examination of the idea of an art hierarchy and other concepts of artistic outsiders and insiders from a variety of positions, taking into account nationality, class, literacy, economics, race, and gender in the categorization and evaluation of art. Instructor: Powell. 3 units.

379. Fascism East and West: The Visual Culture of Japan, Germany, and Italy. Through a close analysis of cultural production and aesthetics, this course examines the relationship between the politics of fascism and its symbolic practices; how forms of rituals, myths, and images played a crucial role in the formation of the fascist regime's self-identity, and the formation of the national fascist subject. Materials include painting, sculpture, architecture, photography, graphic design, mass media, film, and forms of public spectacle and pageantry. Instructor: Weisenfeld. 3 units.

380. Art and Markets. New research that negotiates various possibilities in reuniting ideas, theories, and reception codes, different from those we currently identify. Various scenarios generated will focus on unexpected interplays between images and audiences within their local, timely, and particular socioeconomic frame. Instructor: De Marchi and Van Miegroet. 3 units.

383. Art and Text. This seminar concerns ekphrasis, the problem of using verbal representation to describe visual representation. Study of the interrelation between artists' theoretical writings and visual productions. Students may work on art and texts in all traditional and experimental visual art media, as well as in photography, video, film, and electronic multimedia. Instructor: Stiles. 3 units.

386. Fascism, Art, and Ideology. A study of the cultural politics of European fascism, from its origins in the synthesis of nationalism and socialism before World War I, to its final eclipse in 1945. Analysis of art and architecture in Britain, France, Italy, and Germany in terms of contemporary debates over what constituted a fascist aesthetic. Consideration of the art and writing of the symbolists, futurists, vorticists, La Corbusier, German expressionists, and various German and Italian realists in light of theories of fascism. Instructor: Antliff. 3 units.

387. Art History and Representation. Seminar in the production of art history through various forms of representation, broadly construed, with special attention to issues of aesthetics, social context, historical location, and enunciative position. Consideration of practices of collecting, translation, display, and knowledge formation in order to explore the heterogeneous genealogy of art history. Instructor: Abe. 3 units.

389. Spatial Practices. Space, once a vacuum in which action took place, is now broadly acknowledged as a formidable matrix that shapes agency. From medieval refectories to Starbucks, from Jerusalem to Las Vegas, from mikvaot to hot spring spas, space produced for human use has in turn managed human performance. How space works--as reassuring or threatening, as ordering or disordering--is the subject of this seminar. By reading selected theoretical texts (e.g. Lefebvre, Habermas, Eliade, Zizek) and mapping specific historical landscapes, we will become more aware of the ways space has shaped history and informed the objects of our scholarly research. Instructor Wharton. 3 units.

391. Individual Research in Art History. Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

392. Individual Research in Art History. Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

395. Topics in Art History. In-depth consideration of a specific art historical problem of a formal, historical, or conceptual nature. Consent of instructor required. Instructor: Staff. 3 units.

Visual Arts Courses (ARTSVIS)

208S. Poverty and the Visual. Relationship between art, visual culture, and poverty from the 1950s to the present across cultures. Readings, research, visual analyses, and production assignments based on a broader understanding of poverty as a philosophical, economic, social, and cultural concept. Instructor: Lasch. 3 units.

236S. Experimental Communities. Interdisciplinary seminar examining visual culture and experimental social structures. Readings across academic spectrum focusing on alternative corporate models and workers' unions, early soviet social networks, neighborhood associations, anarchist communes, art collectives, minority alliances, reality TV, fan clubs and fundamentalist organizations, encouraging students to fuse theories of social change with practice to produce new social structures. Class productions may include research papers, performances, experimental theater, social actions, new media works, as well as conventional art forms. Work will be judged by its formal sophistication or aesthetic merits, its social or political relevance, and its engagement with methods of ethical inquiry studied throughout the semester. 3 units. C-L: Visual Studies 236S, Sociology 236S, Cultural Anthropology 236S

266S. The Human as Electrochemical Computer - Toward a New Computational and Aesthetic Paradigm. Weekly discussions/lectures related to different disciplinary understandings of the body, exploring new computational and aesthetic paradigms for brain/mind/body/ environment relations, and working towards articulating bridging languages enabling researchers to talk across disciplines. Students required to participate in ongoing discussion, develop particular aspects of research and write a major research paper. Instructor: Seaman. 3 units. C-L: Visual Studies 266S, Information Science and Information Studies 266S, Arts of the Moving Image 202S
269S. Special Topics in Visual Arts. Special Topics in Visual Arts. Subject varies from year to year. One course. Instructor: Staff. 3 units.

Visual Studies Courses (VISUALST)

200S. Theories of Visual Studies. Capstone seminar focusing on advanced visual studies theories, as well as individual senior projects undertaken as a written research paper or visual production. Consent of instructor required. Prerequisite: Visual Studies 100. Not open to students who have previously taken this course as Art History 208S. Instructor: Abe, Stiles, Weisenfeld. 3 units.

201SL. Wired! New Representational Technologies. Research and study in material culture and the visual arts expressed by using new visual technologies to record and communicate complex sets of visual and physical data from urban and/or archaeological sites. Introduces techniques for the presentation and interpretation of visual material through a series of interpretative and reconstructive technologies, including the development of web-pages (HTML/Dreamweaver), Photoshop, Illustrator, Google Sketch-up, Google Maps, and Flash. To develop techniques of interpretation and representation. Consent of instructor required. Instructor: Brady, Bruzelius, Dillon, or Olson. 3 units.

210. History of Netherlandish Art and Visual Culture in a European Context. A contextual study of visual culture in the Greater Netherlands and its underlying historical and socioeconomic assumptions from the late medieval to early modern period, through immediate contact with urban cultures, such as Amsterdam, Leiden, Utrecht, Brussels, Ghent, Bruges, and Antwerp. Includes daily visits to major museums, buildings, and sites; hands-on research in various collections; discussion sessions with leading scholars in the field; and a critical introduction to various research strategies. (Taught in the Netherlands.) Not open to students who have taken Art History 158-159. Course credit contingent upon completion of Art History 242. Instructor: Van Miegroet. 3 units. C-L: Art History 241, Medieval and Renaissance Studies 241

211. History of Netherlandish Art and Visual Culture in a European Context. Second half of Art History 241-242; required for credit for 241. (Taught in the Netherlands.) Not open to students who have taken Art History 158-159. Instructor: Van Miegroet. 3 units. C-L: Art History 242, Medieval and Renaissance Studies 242

215S. From Caricature to Comic Strip. History of caricature as a medium for political critique and social comment from the eighteenth century to the present, focusing on England, France, Germany, and the United States. Languages of graphic satire in the context of specific historical moments, from the War of Independence to the war in Iraq; history of popular journalism and the comic press; censorship and agitation for press freedom; growth of specialized juvenile graphic magazines and the development of the strip cartoon. Not open to students who have previously taken this course as Art History 221S. Instructor: McWilliam. 3 units.

221S. Black Visual Theory. Approaches to studying and theorizing of African diasporal arts and black subjectivity, with a special emphasis on art historiography, iconology, and criticism, and a particular focus on slavery, emancipation, freedom, and cultural nationalism, as pertaining to peoples of African descent and as manifested in such visual forms as paintings, sculptures, graphics, and media arts from the early modern period to the present, as well as the political edicts, philosophical tracts, autobiographies, and theoretical writings of individuals similarly preoccupied with these ideas. Consent of instructor required. Instructor: Powell. 3 units. C-L: African and African American Studies 210S

225S. Latin American Modernism and Visual Culture. Early twentieth-century modernist movements in Spanish America, Brazil, and the Caribbean. Topics include: race, primitivism, and indigenism; gender; theory of the avant-garde; peripheral modernity; and nationalism, regionalism, and cosmopolitanism. Not open to students who have previously taken this course as Art History 287S. Instructor: Gabara. 3 units.

230S. Trauma in Art, Literature, Film, and Visual Culture. Theories of trauma applied to visual representations of violence, destruction, and pain in contemporary art, film, and literature, examining the topic through multiple subjects from the Holocaust, cults, gangs, racism, and sexual abuse to cultures of trauma. Theories of trauma examined from a variety of sources including clinical psychology, cultural and trauma studies, art, film, and literature, aiming to enable students to gain the visual acuity to identify, understand, and respond to traumatic images with empathy. Not open to students who have previously taken this course as Art History 295S. Instructor: Stiles. 3 units.

231S. Spatial Practices. How space works from medieval refectories to Starbucks, from Jerusalem to Las Vegas, from mikvao to hot spring spas. Consideration of space through theoretical texts, including Lefebvre, Habermas, Eliade, Zizek, and mapped on specific historical landscapes. Consent of instructor required: preference given to students earning concentration in architecture. Not open to students who have previously taken this course as Art History 222S. Instructor: Wharton. 3 units.


235S. Poverty of the Visual. Interdisciplinary seminar on the relationship between visuality and poverty from 1945 to the present. Theorizes visual culture through an examination of the forms of knowledge produced by impoverished populations. Uses philosophical and perceptual methods to explore the limits and limitations of visuality as it applies to science, ethics, the humanities, and the arts. Readings in the humanities and social sciences focus on issues related to lack, scarcity, absence,
minimalism, and invisibility. Students encouraged to fuse theory and practice in research presentations and visual productions. Consent of instructor required. Instructor: Lasch. 3 units.

236S. Experimental Communities. Interdisciplinary seminar examining visual culture and experimental social structures. Readings across academic spectrum focusing on alternative corporate models and workers' unions, early soviet social networks, neighborhood associations, anarchist communes, art collectives, minority alliances, reality TV, fan clubs and fundamentalist organizations, encouraging students to fuse theories of social change with practice to produce new social structures. Class productions may include research papers, performances, experimental theater, social actions, new media works, as well as conventional art forms. Work will be judged by its formal sophistication or aesthetic merits, its social or political relevance, and its engagement with methods of ethical inquiry studied throughout the semester. 3 units. C-L: Sociology 236S, Visual Arts 236S, Cultural Anthropology 236S

250AS. Critical Studies in New Media. 3 units. C-L: see Information Science and Information Studies 250S; also C-L: Literature 261S, Art History 250S

250BS. Technology and New Media: Academic Practice. 3 units. C-L: see Information Science and Information Studies 240S; also C-L: Art History 240S

251A. Media and Democracy. 3 units. C-L: Public Policy Studies 221


260S. Special Topics in Visual Studies. Subjects, areas, or themes that embrace a range of disciplines related to visual studies. Instructor: Staff. 3 units.

265S. Emergent Embodied Interface Design. Seminar exploring issues surrounding embodied approaches to interface design, including bio-memetics; haptic body knowledge; multi-modal sensing; physical computing; physical/digital relationships; networked relations; the potentials of virtual space and different qualities of space, both visual and sonic; as well as database potentials, and emergent generative methodologies for creating works of art, drawings, and diagrams related to these subjects. Instructor: Seaman. 3 units. C-L: Information Science and Information Studies 265S, Arts of the Moving Image 201S

266S. The Human as Electrochemical Computer - Toward a New Computational and Aesthetic Paradigm. Weekly discussions/lectures related to different disciplinary understandings of the body, exploring new computational and aesthetic paradigms for brain/mind/body/ environment relations, and working towards articulating bridging languages enabling researchers to talk across disciplines. Students required to participate in ongoing discussion, develop particular aspects of research and write a major research paper. Instructor: Seaman. 3 units. C-L: Information Science and Information Studies 266S, Visual Arts 266S, Arts of the Moving Image 202S

270S. New Media, Memory and the Visual Archive. Explores impact of new media on the nature of archives as technologies of cultural memory and knowledge production. Sustained engagement with major theorists of the archive through the optics of "media specificity" and the analytical resources of visual studies. Themes include: storage capacity of media; database as cultural form; body as archive; new media and the documentation of "everyday life;" memory, counter-memory, and the politics of the archive; archival materiality and digital ephemeralism. Primary focus on visual artifacts (image, moving image) with consideration of the role of other sensory modalities in the construction of individual, institutional and collective memory. Instructor: Olson. 3 units. C-L: Information Science and Information Studies 207

Biochemistry
Professor Kreuzer, Interim Chair (255 Nanaline H. Duke); Professor Spicer, Director of Graduate Studies (235 Nanaline H. Duke); Professors Bennett, Beem, Beese, Beratan, Casey, Donald, Erickson, Greenleaf, Hellinga, Hershfield, Hsieh, Kreuzer, Lefkowitz, Modrich, McCafferty, Newgard, Nicchitta, Rajagopalan, D. Richardson, J. Richardson, Simon, Spicer, Steege, Toone, York; Associate Professors Fitzgerald, Greene, Kuehn, Oas, Zhou; Assistant Professors Lee, Rutsche; Professors Emeriti Fridovich, Gross, Hammes, Hill, Sage, Siegel, Webster; Adjunct Professors Bell and Blackshear

A PhD is available in this department.

Graduate work in the Department of Biochemistry is offered leading to the PhD degree. Preparation for such graduate study may take diverse forms. Undergraduate majors in chemistry, biology, mathematics, or physics are welcome, but adequate preparation in chemistry is essential. Graduate specialization areas include protein structure and function, crystallography and NMR of macromolecules, nucleic acid structure and function, lipid biochemistry, membrane structure and function, molecular genetics, and enzyme mechanisms. The recommended core requirements consist of mini-courses 258/259 and 267/268, and 291 (or equivalent training), and additional courses in the area of specialization. The Biochemistry Department, in cooperation with the University Programs in Genetics, Cell and Molecular Biology, Structural Biology and Biophysics, offers biochemistry students the opportunity to pursue advanced research and study to fulfill the requirements for the PhD degree related to these fields.
Biochemistry Courses (BIOCHEM)

200. General Biochemistry. An introductory survey of fundamental aspects of biochemistry with emphasis on the structure of macromolecules, mechanism of enzyme action, metabolic pathways, biochemical genetics, and the structure and functions of special tissues. Designed for medical students; graduate students only with consent of instructor. Instructors: Kreuzer, Hershfield, McIntosh, Schachat, Garcia-Blanco, and Nicchitta. 4 units.

210. Research Independent Study. Individual research in a field of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Designed for students interested in either a laboratory or a library project in biochemistry. One course for undergraduate students. One to twelve units for graduate students. Instructor: Staff. Variable credit.

222. Structure of Biological Macromolecules. Computer graphics intensive study of some of the biological macromolecules whose three-dimensional structures have been determined at high resolution. Emphasis on the patterns and determinants of protein structure. Two-hour discussion session each week along with computer-based lessons and projects. Instructors: D. Richardson and J. Richardson. 3 units. C-L: Structural Biology and Biophysics 222, Computational Biology and Bioinformatics 252

227. Introductory Biochemistry I: Intermediary Metabolism. Chemistry of the constituents of proteins, lipids, carbohydrates, and nucleic acids and their metabolic interrelationships. Prerequisite: two semesters of organic chemistry. Instructors: Greenleaf and staff. 3 units.

228. Introductory Biochemistry II. Structure, function, and biosynthesis of biological macromolecules and regulation of their synthesis. Intermediary metabolism and metabolic utilization of energy. Biochemistry of biological membranes, receptors, and signal transduction via membrane receptors. Prerequisite: organic chemistry and Biochemistry 227. Instructors: Been and staff. 3 units.

258. Structural Biochemistry I. Principles of modern structural biology. Protein-nucleic acid recognition, enzymatic reactions, viruses, immunoglobulins, signal transduction, and structure-based drug design described in terms of the atomic properties of biological macromolecules. Discussion of methods of structure determination with particular emphasis on macromolecular X-ray crystallography NMR methods, homology modeling, and bioinformatics. Students use molecular graphics tutorials and Internet databases to view and analyze structures. Prerequisites: organic chemistry and introductory biochemistry. Instructors: Beese and staff. 2 units. C-L: Cell and Molecular Biology 258, Cell Biology 258, University Program in Genetics 258, Immunology 258, Structural Biology and Biophysics 258, Computational Biology and Bioinformatics 258

259. Structural Biochemistry II. Continuation of Biochemistry 258. Structure/function analysis of proteins as enzymes, multiple ligand binding, protein folding and stability, allostery, protein-protein interactions. Prerequisites: Biochemistry 258, organic chemistry, physical chemistry, and introductory biochemistry. Instructors: Hellenga and staff. 2 units. C-L: Cell Biology 259, Immunology 259, Computational Biology and Bioinformatics 259, Structural Biology and Biophysics 259, University Program in Genetics 259

265S. Seminar. Topics and instructors announced each semester. 2 units or variable. Instructor: Staff. Variable credit.


268. Biochemical Genetics II: From RNA to Protein. Mechanisms of transcription, splicing, catalytic RNA, RNA editing, mRNA stability and translation. Mini-course, 2nd half semester. Instructors: Steege and Staff. 2 units. C-L: Cell Biology 268, Immunology 268, University Program in Genetics 268

291. Physical Biochemistry. Basic principles of physical chemistry as applied to biological systems. Topics include thermodynamics, kinetics, statistical mechanics, spectroscopy, and diffraction theory. Concepts discussed in the context of the biochemistry and behavior of biological macromolecules. Emphasis on quantitative understanding of biochemical phenomena, with extensive problem solving as an instructive tool. Prerequisite: undergraduate physical chemistry and one year of calculus. Instructor: Oas and staff. 3 units. C-L: Structural Biology and Biophysics 291

336. Bioorganic Chemistry. 4 units. C-L: see Chemistry 336

345. Biochemistry Seminar. Required of all second- and third-year biochemistry students. Credit/no credit grading only. Instructor: Staff. 1 unit.

346. Biochemistry Seminar. Required of all second- and third-year biochemistry students. Credit/no credit grading only. Instructor: Staff. 1 unit.

417. Cellular Signaling. 3 units. C-L: see Cell Biology 417; also C-L: Molecular Cancer Biology 417, Pharmacology and Cancer Biology 417

Biological and Biologically Inspired Materials

Ashutosh Chilkoti, PhD, Director

This is an admitting program.

A certificate is also available in this program.
The Certificate in Biological and Biologically Inspired Materials (BBIM) is the cornerstone of the Center's multidisciplinary graduate training. It is an admitting certificate program, but the BBIM course of study can be pursued by any interested engineering or science student. Completion of the certificate program is requirement of the CBIMMS IGERT training grant.

CBIMMS faculty designed the BBIM curriculum to serve as a hands-on introduction to the concepts of Biological and Biologically Inspired Materials. The "soft/wet" materials of the biological world—as distinct from the "hard" materials of traditional engineering—require a thorough multidisciplinary approach for any sort of useful understanding. The BBIM curriculum, with its required courses and many electives, serves as a gateway to the conversation across disciplines. Students from departments as diverse as Chemistry and Mechanical Engineering, Biomedical Engineering and Cell Biology, develop a common vocabulary—and a common set of tools—to solve biomaterials problems.

Anchored by David Needham's Introduction to Biologically Inspired Materials course, which introduces the basic concepts of biological inspiration, the curriculum includes a class introducing advanced instrumentation, the BioE Seminar Series, and a number of elective courses in a broad range of disciplines.

The Certificate in Biological and Biologically Inspired Materials is open to any engineer or science PhD student who wishes to pursue the course of study. The certificate program is intended to provide advanced training in quantitative methods in an interdisciplinary context, and to facilitate research across disciplinary boundaries. For more information visit [http://www.cbimms.duke.edu/](http://www.cbimms.duke.edu/).

**Certificate Requirements:**
- Applications are typically made late in the second year or later.
- Two required core courses
- A minimum of five graduate elective courses
- Regular attendance and participation in the academic seminar series
- An advanced material laboratory training series offered through the Shared Materials Instrumentation Facility

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**Biology**

Professor Kiehart, *Chair* (143 Biological Sciences Building); Associate Professor Johnsen, *Director of Graduate Studies* (139 Biological Sciences Building); Professors Alberts, Barber, Benfey, Brandon, Christensen, Clark, Crowder, Cunningham, Dong, Forward, Goldstein, Jackson, Kiehart, Kirby, Manos, McClay, Mitchell-Olds, Morris, F. Nijhout, Noor, Nowicki, Rausher, Reynolds, Rodrigo, Rosenberg, Shaw, Siedow, Smith, Staddon, Sun, Terborgh, Uyenoyama, Vilgalys, Willard, Willis, Wray, and Yoder; Associate Professors Bejsovec, Drea, Haase, Johnsen, Lutzoni, McShea, Pei, Pryer, Rittschof, Roth, and Wilson; Assistant Professors Baugh, Bhandawat, Bernhardt, Chen, Koelle, Leal, Magwene, Schmid, D. Sherwood, Volkna, Wright; Professors Emeriti Boynton, Fluke, Gillham, Klopfner, Knox, Nicklas, Searles, Stone, Strain, Tucker, Wainwright, Ward, White, and Wilbur; Research Professors Cook-Deegan, Livingstone and Vogel; Assistant Research Professor N. Sherwood; Senior Research Scientist Culberson; Adjunct Associate Professor M. Nijhout

**The Department of Biology offers a variety of training opportunities leading to the PhD degree.**

Students in the department may specialize in a wide variety of areas including anatomy; biology; behavior; physiology; cellular and molecular biology; community, ecosystem, physiological, and population ecology; evolution; functional morphology; developmental, ecological, molecular, organelle, and population genetics; genomics; and systematics.

There is a high level of interaction among the various areas of biology and other programs. Faculty members participate in the University Programs in Developmental Biology, Ecology, Genetics and Genomics, Cellular and Molecular Biology, Computational Biology and Bioinformatics, Structural Biology and Biophysics, and Neurobiology; tropical research is facilitated through the University's membership in the Organization for Tropical Studies. There are also strong relationships with the departments of Evolutionary Anthropology (primatology, phylogenetic systematics, macroevolution), Mathematics (theoretical biology), and Psychology (behavior); the School of Engineering (biomechanics); the Medical Center (molecular biology and genomics); and the Nicholas School of the Environment and Earth Sciences (ecology).

Students entering the program generally have a broad background in biological sciences supplemented with basic courses in chemistry, mathematics, and physics. Biochemistry and physical chemistry are strongly recommended for students interested in molecular areas, and advanced courses in mathematics are recommended for students in population genetics and ecology. While deficiencies may be corrected by taking appropriate courses during the first year of graduate study, it is advised that students search widely in both the *Bulletin of Duke University: Undergraduate Instruction* and the *Bulletin of Duke University: Graduate School* for information about the intellectual resources of the University. Special attention should be given to announcements of the programs and departments listed above, as well as to those of Cultural Anthropology, History, Immunology, Molecular Genetics and Microbiology, Pharmacology, Philosophy, and Sociology, and of the School of Engineering and the Nicholas School of the
Biology (BIOLOGY)

203L. Marine Ecology. Ecology from a policy and management perspective. Recitations and discussions target a policy- and management-oriented graduate audience. Lecture topics include factors that influence the distribution, abundance and diversity of marine organisms, characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shore, tidal flats, beached, mangrove, coral reefs and subtidal areas. Recitations and discussions cover ecological principles form a policy and management perspective. Not open to students who have taken BIO 129L and not open to undergraduates. (Given at Beaufort fall and summer). Prerequisite: Introductory Biology. Instructors: Crowder or Kirby-Smith. 4 units. C-L: Environment 219

203L. Marine Ecology. Ecology from a basic science perspective. Laboratories target a science-oriented graduate audience. Lecture topics include factors that influence the distribution, abundance, and diversity of marine organisms, characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shores, tidal flats, beaches, mangrove, coral reefs, and subtidal areas. Laboratories and field trips cover ecological principles from a basic science perspective. Not open to students who have taken BIO 129L and not open to undergraduates. (Given at Beaufort.) Prerequisite: Introductory Biology. Instructors: Crowder or Kirby-Smith. 4 units. C-L: Environment 219L

205L.S. Experiments in Developmental and Molecular Genetics. Experimental approaches in development and genetics using animal and plant models. Laboratory training in molecular genetics, immunochemistry, microscopy, protein chemistry, and genetic screening. Experiments include immunochemical localization, in situ hybridization, polymerase chain reaction, genetic screening, embryonic micromanipulation, microscopic imaging, and mutant analysis. Prerequisite: Biology 101L or 118; recommended, prior or concurrent registration in Biology 119. Instructor: Spera. 4 units.


207AL. Experimental Tropical Marine Ecology. Distribution and density of marine and semi-terrestrial tropical invertebrate populations; behavioral and mechanical adaptations to physical stress, competition, and predation using rapid empirical approaches and hypothesis testing. Offered only at Beaufort, with preparation for fieldwork before and analysis and presentation of projects after required one week intensive field experience on the coast of Panama. Consent of instructor required. Instructor: Diaz. 2 units. C-L: Marine Sciences

207BL. Marine Ecology of the Pacific Coast of California. Ecology of the rocky intertidal, kelp forest, and mud flat habitats. Introduction to marine mammals, fish and other large West Coast vertebrates. Offered only at Beaufort, with preparation for fieldwork before and analysis and presentation of projects after required one week intensive field experience on the coast of Northern California. Prerequisite: Concurrent registration in Biology 129L and consent of instructor. Instructor: Crowder. 2 units. C-L: Marine Sciences

207EL. Harmony in Brittany: French Use of Marine Environments. Intensive field experience on the coast of Brittany, including French maritime cultural heritage, regional and national coastal reserves (Le Pare naturel régional d'Armorique; Presqu'île de Crozon), shellfish aquaculture (La Tremblade), seaweed harvest (Lanildut), and tidal energy (La Rance). Offered only in Beaufort, with preparation for fieldwork before and analysis and presentation of projects after required one week intensive field experience on the coast of France over Fall Break. Prerequisites: AP Biology or introductory biology and consent of instructor. Instructor: Van Dover. 2 units. C-L: Marine Sciences

208S. Human Embryology. The development of the mammalian embryo. Emphasis on human embryology, the origin of major human teratologies, birth defects, ethical and social issues of reproductive biology, aspects of comparative vertebrate development. The evolution of developmental patterns, and the molecular mechanisms of development. Prerequisites: Biology 108L or 205L or Evolutionary Anthropology 133L or equivalent. Permission of instructor required. Instructor: Smith and Wall. 4 units. C-L: Evolutionary Anthropology 208S

211L. Microbial Ecology and Evolution. Survey of new advances in the field of environmental and evolutionary microbiology, based on current literature, discussion, and laboratory exercises. Topics to include bacterial phylogeny, molecular ecology, emerging infectious diseases, bacterial symbiosis, experimental evolution, evolution of drug resistance, and microbial genomics. Prerequisite: Biology 19 or 25L or 103L or 101L or 118 or consent of instructor. Instructor: Vilgalys. 4 units.

214. Biophysics in Cellular and Developmental Biology. 3 units. C-L: see Physics 214

215. Tropical Ecology. 3 units. C-L: see Environment 217


217. Ecology and Global Change. Feedbacks between ecological processes and global environmental change; physiological
and ecosystem ecology using a variety of sources, including the primary scientific literature. Topics include global warming, biodiversity, land-use change, ozone depletion, and the application of ecological research to policy. Prerequisite: Biology 110L or 116 or introductory ecology. Instructor: Jackson. 3 units.

220L. Mycology. Survey of the major groups of fungi with emphasis on life history and systematics. Field and laboratory exercises. Instructor: Vilgalys. 3 units.

221S. Topics in Advanced Mycology. Current research on fungal evolution, genetics, physiology, and ecology. Prerequisite: Biology 220L or consent of instructor. Instructor: Vilgalys. 3 units.

222L. Entomology. The biology of insects: diversity, development, physiology, and ecology. Field trips. Prerequisite: Biology 19 or 25L or 102L or equivalent. Instructor: H. Nijhout. 4 units.

223S. Biology of Mammals. The biology of mammals: diversity, evolutionary history, morphology, and aspects of physiology and ecology. Local field trips. Prerequisite: Biology 19 or 25L or 102L or equivalent. Instructor: Roth. 3 units.

224L. Herpetology. Biology of recent amphibians and non-avian reptiles, evolutionary history, morphology, life history, physiology, behavior, and ecology. Local field trips. Prerequisites: Biology 25L or equivalent. Instructor: Leal. 4 units.

234S. Problems in the Philosophy of Biology. 3 units. C-L: see Philosophy 234S


237L. Systematic Biology. Laboratory version of Biology 237. Theory and practice of identification, species discovery, phylogeny reconstruction, classification, and nomenclature. Prerequisite: Biology 25L or 102L or equivalent. Instructors: Lutzoni and Swofford. 4 units.

240. Development of Neural Circuits. Lectures on molecular pathways regulating development and assembly of neural networks in the brain through out the lifespan of the organism. Comparative exploration of sensory neural circuits in different model systems (fly, worms, and rodents). Includes discussion of the classic and recent literature. Prerequisites: Biology 101L or 118 and Biology 115. Instructor: Volkman. 3 units. C-L: Neuroscience 245

241S. Biology of Nervous System Diseases. Primary literature investigating the underlying molecular and cellular mechanisms of nervous system disorders such as neurodegenerative diseases (Alzheimer's, Parkinson's, Huntington's), mental illness, and epilepsy. Prerequisite: Neuroscience 114 or 115 or Biology 119 or consent of instructor. Instructor: Sherwood, Nina. 3 units. C-L: Neuroscience 242S, Psychology 211S

244. Principles of Immunology. 3 units. C-L: see Immunology 244

252. Marine Conservation Biology. Ecological effects of fishing, the major threat to marine biodiversity, examined through selected case studies. Conservation strategies and ways that science and policy can be integrated to solve real-world problems. Field trip to Hawaii required. (Taught at Beaufort.) Instructor: Read. 3 units.

253L. Physiology of Marine Animals. Variable credit. C-L: see Environment 228L

254. Vertebrate and Invertebrate Endocrinology. Comparative study of the major pathways of hormonal regulation from the organism to the molecular level in vertebrate and invertebrate models. Applications of endocrinology in pharmaceuticals, cosmetics, and environmental issues. Prerequisites: AP Biology or introductory biology or consent of instructor and Chemistry 152L. A biochemistry course recommended. (Given at Beaufort.) Instructor: Rittschof. 3 units. C-L: Marine Sciences

255L. Biochemistry of Marine Animals. Variable credit. C-L: see Environment 229L

256S. Speciation. Experimental and phylogenetic approaches to the origin of plant and animal species. Emphasis on current literature and modern approaches to evolutionary patterns and processes. Prerequisites: basic courses in systematics and genetics. Instructors: Noor and Willis. 3 units.

258S. The Making of the Modern Evolutionary Synthesis. An examination of the intellectual and historical development of the modern evolutionary synthesis. Topics will include: the state of evolutionary theory and the debate between the "Mendelians" and "Darwinians" in the early part of the 20th century, the development of modern population genetics and its synthesis with ecology, systematics and paleontology. Contributions of Fisher, Wright, Dobzhansky, Mayr, and Simpson will be highlighted with focus on original literature. What was and was not part of the synthesis, and why, and the current state of evolutionary theory will also be discussed. Enrollment limited to graduate students. Instructors: K. Smith and J. Willis. 3 units.

259S. The Life and Work of Darwin. Readings by and about Darwin and his contemporaries, especially Wallace. Darwin's "Autobiography" and Janet Browne's biography as context for readings of some of his major works and works of his contemporaries. Consent of instructor required. Instructors: Alberts and McShea. 3 units.

260. Cancer Genetics. Overview of the genetic changes associated with cancer and the molecular events that transform normal cellular processes into tumor-promoting conditions. Topics include: tumor viruses, oncogenes, growth factors, signal transduction pathways, tumor suppressors, cell cycle control, apoptosis, stem cells, and metastasis. Prerequisites: Biology 101L and 102L or Biology 118. Recommended: Biology 117 or 119. Instructor: Bejsovec. 3 units.

262S. Molecular Genetic Analysis. Application of genetic techniques to basic problems in cell and developmental biology. Readings in the primary literature will focus on model systems such as C. elegans and Drosophila. Topics will include: forward and reverse genetic screen strategies, mosaic analysis and transgenesis. Prerequisite: Biology 118 or Biology 101L and 102L.
or equivalent. Instructor: Bejsovec. 3 units.

267L. Biodiversity Science and Application. Processes responsible for natural biodiversity from populations to the globe. Topics include species interactions (e.g., competition, predation, parasitism), natural and human disturbance, climate change, and implications for management and conservation. Lab section involving observation and data from large-scale manipulations, such as experimental hurricanes, fire, and herbivore exclosures. Instructors: Clark and Wright. 3 units. C-L: Environment 257L

268L. Models for Environmental Data. Formulation of environmental models and applications to data. Topics include physiology, population growth, species interactions, disturbance, and ecosystem dynamics. Model development, analysis, and interpretation. Discussions focus on classical and current primary literature. Lab focuses on analysis of data using R, making use of likelihood models, bootstrapping, and Bayesian approaches. Instructor: Clark. 3 units. C-L: Environment 231L

271L. Genomics Laboratory. Introduction to the field of genomics. Genomic techniques including genome sequencing, microarray analysis, proteomics, and bioinformatics; applications of genomics to understanding biological problems including biological networks, human origins, evolution; applications to medicine and agriculture. Computer-based research lab with participation in collaborative bioinformatics projects. Prerequisites: Biology 101L or 118 or consent of instructor. Instructor: Spana. 4 units.

272. Biogeochemistry. Processes controlling the circulation of carbon and biochemical elements in natural ecosystems and at the global level, with emphasis on soil and surficial processes. Topics include human impact on and social consequences of greenhouse gases, ozone, and heavy metals in the environment. Prerequisite: Chemistry 31L or equivalent; Recommended: Chemistry 32L. Instructor: Bernhardt. 3 units. C-L: Environment 282

274. Genomic Perspectives on Human Evolution. Human evolutionary history as studied from the perspective of the genome. Nature of contemporary genomic data and how they are interpreted in the context of the fossil record, comparative anatomy, psychology, and cultural studies. Examination of both the origin of modern humans as a distinct species and subsequent migration across the world. Emphasis on language, behavior, and disease susceptibility as traits of particular evolutionary interest. Prerequisite: Biology 101L and 102L or 118 or equivalent course. Instructor: Wray. 3 units. C-L: Evolutionary Anthropology 274

274L. Marine Invertebrate Zoology. Variable credit. C-L: see Environment 295L

275S. Sensory Signal Transduction. Recent progress in sensory signal transduction mediated by calcium channels and receptors. Topics include history and techniques in the study of ion channels, such as electrophysiology, calcium imaging, and cell and molecular biology; cell surface perception for external signals, including light receptors, olfactory receptors, taste receptors, hot and cold receptors, and mechanical receptors; heart and brain pacemakers; sensory channel receptor-related human diseases; and plan sensory signaling network. Instructor: Pei. 3 units.

277S. Foundations of Behavioral Ecology. Readings on behavioral ecology, both historical papers and papers from the current literature that represent the most vital areas of research in the discipline. Instructors: Alberts. 3 units.

278S. Genetic Basis of Behavior. The relationship between genotype and behavioral phenotype. Readings from the primary literature, including papers on humans, lab mice, and wild animal populations. Exploration of two philosophical topics: the question of causality in the natural world and the question of determinism in biology. Short research paper required. Instructor: Alberts. 3 units.

279S. Developmental and Stem Cell Biology Colloquium. Lectures, seminars, and discussion of current topics in developmental biology. Prerequisites: Biology 101L or 118 and/or 119 or equivalent. Consent of instructor required. Instructor: Sherwood. 3 units.

280S. Genetic Engineering and Biotechnology. Applications of recombinant DNA in medicine and in agriculture. Topics include diagnosis of genetic diseases, gene therapy, drugs for AIDS and cancer, DNA fingerprinting, cloning of mammals, phytoremediation, crop improvement, and pharmaceutical protein production in transgenic plants and animals. Social and environmental impacts of biotechnology. Prerequisites: Biology 101L or 118 or consent of instructor. Instructor: Sun. 3 units.

281S. Systems Biology Colloquium. Lectures, seminars, and discussion of current topics in systems biology. Introduction to both experimental and quantitative approaches to understanding the function of biological networks. Weekly lectures by experts in the field. Instructor: Haase. 3 units.


283. Developmental Genetics. 2 units. C-L: see Cell Biology 283

284. Molecular Population Genetics. Genetic mechanisms of evolutionary change at the DNA sequence level. Models of nucleotide and amino acid substitution; linkage disequilibrium and joint evolution of multiple loci; analysis of evolutionary processes, including neutrality, adaptive selection, and hitchhiking; hypothesis testing in molecular evolution; estimation of evolutionary parameters; case histories of molecular evolution. For graduate students and undergraduates with interests in genetics, evolution, or mathematics. Instructor: Uyenoyama. 3 units.

287S. Macroevolution. Evolutionary patterns and processes at and above the species level; species concepts, speciation, diversification, extinction, ontogeny and phylogeny, rates of evolution, and alternative explanations for adaptation and evolutionary trends. Prerequisite: Biology 25L, 26L, 102L, or other course in plant or animal diversity; recommended, Biology
126 or equivalent. Instructor: Roth. 3 units. C-L: Evolutionary Anthropology 287S

288S. Ecology and Evolutionary Biology Colloquium. Lectures, seminars, and discussion of current research in ecology and evolution. Guest lectures will focus on research at Duke. Intended for advanced undergraduates. Prerequisites: Biology 116 or 102L and one course in ecology. Instructor: J. Noor. 3 units.

289S. Advanced Topics in Genome Science Research. Exploration of current experimental and computational approaches in genomics and genetics and their applications to contemporary research questions. Formulation and design of interdisciplinary research plans with discussion of implications for biology, medicine and society. Utilizing primary scientific literature, students write critical reviews and research proposals. Prerequisite: Biology 101L or 194FCS or 118, 119 or 271, or consent of instructor. Recommended co- or prerequisite: independent study in genomics or computational biology. Instructor: Willard. 3 units.

292. Population Ecology. Key questions in population ecology from a theoretical perspective. Topics include demography and dynamics of structured populations, population regulation, stochastic and spatial population dynamics, life history characteristics, species interactions, and conservation of threatened populations. Computer labs will emphasize fitting models to data. Prerequisites: Biology 110L or 116 or introductory ecology or equivalent. Instructor: Morris and/or Wilson. 3 units.

293. Simulating Ecological and Evolutionary Systems. Computer programming using C within a UNIX environment applied to ecological and evolutionary problems. The relationship between simulation and analytic modeling. Knowledge of programming or work within the UNIX computer environment not expected. Consent of instructor required. Instructor: Wilson. 3 units.

295. Topics in Biology. Lecture course on selected topic. Offerings vary each semester. Instructor: Staff. 3 units.

295S. Special Topics Seminar. Seminar on a selected topic. Offerings vary each semester. Consent of instructor required. Instructor: Staff. 3 units.

296. Topics in Biology. Lecture version of Biology 296S. Offerings vary each semester. Instructor: Staff. 2 units.

296S. Special Topics Seminar. Seminar on a selected topic. Offerings vary each semester. Consent of instructor required. Instructor: Staff. Variable credit.

297. Research Independent Study. Continuation of Biology 191. Individual research and reading of the primary literature in a field of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to juniors and seniors only with consent of supervising instructor. May be repeated. Instructor: Staff. 3 units. C-L: Marine Sciences 299S. Writing in Biology. Conventions of scientific writing, focusing on the process of writing a thesis or other major research paper in the biological sciences. Course intended for all candidates for Graduation with Distinction in Biology. Instructor: Reynolds, JA. 3 units.

300. Tropical Biology: An Ecological Approach. Highly intensive, field-oriented course conducted in Costa Rica under auspices of the Organization for Tropical Studies. For additional information refer to the chapter "Special and Cooperative Programs." 6 to 8 units. Instructor: Staff. Variable credit.

303. Principles of Environmental Modeling. Design, implementation, and interpretation of mathematical and computer models in environmental science and management. Combination of lectures, discussion sessions, and computer lab exercises. Goals of course are to develop skills: (1) to conceptualize environmental problems and (2) to design, program, implement and interpret mathematical and computer models to help solve environmental problems. Instructor: Reynolds. 3 units. C-L: Environment 303

306S. Plant Systematics Seminar. Weekly presentation of current research in plant systematics by students, faculty, and invited speakers. Instructor: Vilgalys. 1 unit.

307. Succeeding in Graduate School in the Biological Sciences. Weekly lecture presentation on choosing a thesis advisor, the grant proposal and scientific manuscript peer review processes, and other topics related to succeeding in graduate school. Instructor: Noor. 0.5 units.

308. Succeeding Beyond Grad School: Career Options with a PhD in the Biological Sciences. Weekly lecture presentation on preparing academic job applications, alternative careers in the biological sciences and other topics related to succeeding beyond graduate school. Instructor: Noor. 0.5 units.

309. Ecological Forecasting Workshop. 3 units. C-L: University Program in Ecology 309

311S. Ecology Seminar. Discussion of current research and literature. Instructor: Staff. 1 unit.

313. Statistical Computing for Biologists. Statistical computing for the biological sciences with an emphasis on common multivariate statistical methods and techniques for exploratory data analysis. Goal of the course is to help graduate students in the biological sciences develop practical insights into methods they are likely to encounter in their research. Provides introductions to "R" statistical computing environment and Python programming language. Instructor: Magwene. 3 units.

315S. Population Genetics Seminar. Discussion of recent developments in population genetics. Topics include population dynamics, forces affecting gene frequency change, molecular evolution, philosophy of evolutionary biology. Student presentations are integral to the course. Instructor: Staff. 1 unit.

322S. Behavioral, Population, and Community Ecology Discussion Group. An informal discussion group. Topics vary
from semester to semester. Instructor: Dong. 1 unit.

325S. Developmental, Cellular, and Molecular Biology Seminar. Weekly presentations in developmental, cellular, and molecular biology topics by students, faculty, and invited speakers. Consent of instructor required. Instructor: Staff. 1 unit.

326S. Developmental, Cellular, and Molecular Biology Seminar. Weekly presentations in developmental, cellular, and molecular biology topics by students, faculty, and invited speakers. Consent of instructor required. Instructor: Staff. 1 unit.

328S. Plant Biology Forum. Modern contemporary research on the plant model species Arabidopsis thaliana. Prerequisites: Coursework in molecular and cell biology. Instructor: Chen. 1 unit.

334L. Bryophyte Biology and Ecology. Identification, classification, evolution, and ecology of bryophytes (mosses, liverworts, and hornworts). An ecological survey of bryophytes in their natural habitats focusing on the skills required to identify bryophytes and use them as indicators of environmental features. Natural plan communities of the southeastern United States. Uses of bryophytes for ecological assessment. Prerequisites: Course in introductory biology and organismal diversity, or equivalent. Instructor: Shaw. 4 units.

351. Tutorial. Carried out under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. Variable credit.

353. Research. To be carried on under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. Variable credit.

370. Principles and Practice of Microscopy. Concepts involved in a wide variety of microscopy, demonstrations of various imaging systems and discussions of specialist techniques. The course is intended for people who will do a significant amount of biological imaging in their graduate research. Areas covered: Transmitted light, fluorescence, widefield imaging, scanning confocal, TIRF, live-cell imaging, multiphoton excitation, image processing and analysis. Consent of instructor required. Instructor: Johnson. 1 unit.

378. Genetic Approaches to the Solution of Biological Problems. 4 units. C-L: see University Program in Genetics 378; also C-L: Cell and Molecular Biology 378, Molec Genetics & Microbiology 378

390. Seminar in Teaching Biology. Syllabus design, best practices, and instructional methods in biology for graduate students in Duke University's Preparing Future Faculty Program in Biology. Seminar discussions and projects guided by Duke faculty in conjunction with faculty from Elon, Guilford, and Meredith Colleges. Topics may include "Biological Literacy"; "Using Information Technology"; and "Different Learning Styles, Different Contexts." Consent of instructor required. Instructor: J. A. Reynolds. 1 unit.

395. Topics in Biology. Lecture course on selected topic. Offerings vary each semester. Instructor: Staff. Variable credit.


Biology, Teaching College
See listing for Teaching College Biology.

Biomolecular and Tissue Engineering

W. M. Reichert, PhD, Program Director

A certificate is available in this program.

The University Program in Biomolecular and Tissue Engineering is a multidisciplinary certificate program that integrates activities in engineering, the life sciences, and medicine. Faculty are from the Departments of Biochemistry, Biomedical Engineering, Cell Biology, Chemistry, Mechanical Engineering and Materials Science, Medicine, Neurobiology, Ophthalmology, Radiation Oncology and Surgery.

The program emphasizes research, education (both undergraduate and graduate) and interactions with industry. The research focus of the program is upon the action of proteins, cells and tissues—and the materials (both natural and synthetic) with which they interact—in natural biological processes, and in medical diagnosis and therapy. It applies the principles and experimental methods of engineering to improve the understanding of these phenomena, and uses this knowledge to develop solutions to practical as well as fundamental problems. Students apply for graduate study to participating departments and are subject to the degree requirements of the university and these home departments.

The University Program in Biomolecular and Tissue Engineering offers a certificate of graduate study. The requirements for the certificate include completion of two core courses: Protein Engineering (BME 220) and Seminars in Biomolecular and Tissue Engineering (BME 301/302); approved BTE Engineering electives; and, two approved Basic Science classes. A NIGMS biotechnology training grant offers stipends, tuition and fees to a number of BTE predoctoral fellows.

Requirements (Engineering Department):

- One lab-based class in modern biotechnology.
- Two semesters credit of Biological Engineering Seminar series.
- Four BTE electives.
• Two non-engineering biomedical science classes.

Requirements (Non-Engineering Department):
• One lab-based class in modern biotechnology.
• Two semesters of credit of Biological Engineering Seminar series.
• Two BTE electives.
• Two non-engineering biomedical science classes.

For more information contact The University Program for Biomolecular and Tissue Engineering, Duke University, Box 90281, Durham, North Carolina 27708-0281 or visit the Web site at: http://cbte.pratt.duke.edu/.

Business Administration
Professor Sheppard, Dean (219W Fuqua School of Business); Professor Bettman, Director of Graduate Studies (A312 Fuqua School of Business); Professors Amaldoss, Anton, Ariely, Arora, R. Ashton, Bansal, Bernstein, Boulding, Brandt, Brav, Breeden, Burton, Chartrand, Clemen, W. Cohen, Coleman, Desai, Fischer, Fitzsimons, Francis, Gallant, Graham, Harvey, Hsieh, Huber, Kamakura, Larrick, Laughhun, Lewin, Lewis, Lind, Luce, Lynch, Marx, Mela, Mitchell, Moorman, Nau, Payne, Puri, Purohit, Robinson, Schipper, Sheppard, Sitkin, J. Smith, Song, Staelin, Venkatachalam, Viswanathan, Winkler, and Zipkin; Associate Professors A. Ashton, Britton, Brown, Chatterji, Q. Chen, Cummings, Dikolli, Gervais, Jennings, Kaniel, Kok, Linville, Lopomo, Mathews, Mayew, McAdams, Olsson, Pekec, Rampini, Rosette, Shang, Soll, Sun, Wade-Benzenzi, Zehner; Assistant Professors Ai, Belenzon, Belloni, L. Chen, Daley, Dyreng, Ecker, Ertimur, Fabrizio, Huesch, Joseph, Musalem, Ridley, Wilbur, Williams, Zarutskie; Professors Emeriti Baligh, Bradley, K. Cohen, Keller, McCann, and Moore; Research Professor Keeney

The PhD in business administration program prepares candidates for research and teaching careers at leading educational institutions and for careers in business and governmental organizations where advanced research and analytical capabilities are required. The PhD program places major emphasis on independent inquiry, on the development of competence in research methodology, and on the communication of research results. The school offers programs of research and training in the areas of accounting, decision sciences, finance, management, marketing, operations management, and strategy. The student and the faculty in his/her area determine the specific program of study. Each student completes a comprehensive examination or a major area paper requirement by the end of their third year. The final requirement is the presentation of a dissertation. The PhD program usually requires five years of work. Refer to the Bulletin of Duke University: The Fuqua School of Business for a complete list of courses and course descriptions. For further information, e-mail bobbiec@mail.duke.edu or jrb12@mail.duke.edu, or visit the Web site: http://www.fuqua.duke.edu.

Business Administration Courses (BA)
501. Game Theory. Basic topics in noncooperative game theory: representations of games in normal and extensive form and solution concepts, including Nash equilibrium, subgame perfect Nash equilibrium, perfect Bayesian equilibrium, sequential equilibrium, perfect equilibrium, proper equilibrium, correlated equilibrium, iterated dominance, and rationalizability. Discussion of the relation between the normal and extensive form and the relations among the various solution concepts. Application of interest to the students covered as time permits. Instructor: Marx. 3 units.

510. Bayesian Inference and Decision. Methods of Bayesian inference and statistical decision theory, with emphasis on the general approach of modeling inferential and decision-making problems as well as the development of specific procedures for certain classes of problems. Topics include subjective probability, Bayesian inference and prediction, natural-conjugate families of distributions. Bayesian analysis for various processes, Bayesian estimation and hypothesis testing, comparisons with classical methods, decision-making criteria, utility theory, value of information, and sequential decision making. Instructor: Winkler. 3 units. C-L: Statistical Science 221


512. Dynamic Programming and Optimal Control. Basic models and solution techniques for sequential decision making under uncertainty. Discrete and continuous time models with finite and infinite planning horizon. Applications drawn from economics, finance, operations management and engineering. Instructor: Sun. 3 units.

513. Choice Theory. This seminar deals with the foundations and applications of the theory of rational choice, including Bayesian decision theory (subjective expected utility) as well as nonexpected utility theory, noncooperative game theory, and arbitrage theory. It will survey the classic literature in the field and discuss the interconnections among its branches; dissect a variety of paradoxes, puzzles, and pathologies; and discuss recent advances and controversies. The goal of this seminar is to equip students with an understanding of both the power and the limits of rational choice theory, so that they can construct as well as critically analyze rational choice applications in a wide variety of social science contexts. It will also suggest some new directions for choice-theoretic research that involve a synthesis of ideas from competing paradigms. Instructor: Nau. 3 units. C-L: Statistical Science 234
521. Organization Seminar: A Micro Focus. Individual and small-group behavior in organizations. Theories of motivation, decision making, interpersonal behavior, group processes, and leadership. A variety of research approaches and methods include presentation of behavioral research by members of The Fuqua School of Business and other researchers. Instructor: Staff. 3 units.

522. Organization Seminar: A Macro Focus. The organization and the subunits which make up the organization. Topics include: contingency theory, institutional theory, and population ecology. Theories of organization, structure, decentralization, divisionalization, functional area integration, task design, incentives and rewards, information systems, and decision rules are developed with an orientation toward their choice and design for high performance. Includes presentation of research by members of The Fuqua School of Business and other researchers. Instructor: Staff. 3 units.

525. Behavioral Decision Theory. Examines the development of research in individual and group decision behavior. Major emphasis is given to theoretical developments and empirical research, with a range of articles assigned for each topic. The basic topic areas include: (1) decision problem structuring, (2) thinking about uncertainties, (3) risk taking, (4) dealing with conflicting values, and (5) combining individual judgments into a group decision. Instructor: Payne. 3 units. C-L: Psychology 316, Statistical Science 231

531. Accounting Seminar: Empirical. This course focuses on empirical-archival research in accounting, emphasizing the framing of research questions, the research design and the research methods. Topics covered include: the value of relevance and stewardship roles of accounting information; valuation models; voluntary disclosure and accounting choice; earnings management; tax considerations. Prerequisites: PhD level course in microeconomics recommended; basic mathematics background in calculus, statistics and algebra. Instructor: Staff. 3 units.

532. Accounting Seminar: Analytical. This course focuses on the economic models underlying information economics-based theories of the usefulness of accounting information. Topics covered include: adverse selection, moral hazard, incentive contracting and disclosure. Prerequisites: PhD level courses in microeconomics and econometrics, MBA level financial accounting course, and BA 531 is required; or approval by instructor on a case-by-case basis. Strong mathematics background in calculus, statistics and algebra. Instructor: Staff. 3 units. Instructor: Chen. 3 units.

533. Accounting Seminar: Behavioral. Introduces Accounting Ph.D. students to judgment/decision making research in accounting that is informed by cognitive and social psychology and economics and that relies on experimental research methods. Choices made by market participants such as securities analysts and investors, the determinants of those choices, and their effects on these and other participants in the economic system are considered. The course is designed for students whose major interests involve economics-based archival research in financial accounting and reporting issues who need to understand complementarities between archival and experimental research approaches. Instructor: Ashton. 3 units.

551. Introduction to Finance (Finance I). This course provides a comprehensive yet rigorous introduction to both the theory and related empirical evidence of modern financial economics. Topics covered include (i) preferences and expected utility theory; (ii) single-period portfolio choice, mean-variance optimization, and CAPM; (iii) efficient markets, predictability, cross-sectional anomalies, and event studies; (iv) stochastic discount factors, no arbitrage, state prices, and contingent claims; (v) APT and multifactor pricing models; and (vi) behavioral finance. Instructor: Staff. 3 units.

552. Finance II. This course is intended to introduce students to research topics in empirical corporate finance. The course is roughly divided into two parts. In the first part, we spend considerable amount of time on canonical early papers in corporate finance, most of which deal with the role of various capital market imperfections, such as taxes, moral hazard, or asymmetric information, in the determination of optimal capital structure. We also examine the empirical literature these early papers have spawned. In the second half of the course, we examine a range of current topics in empirical corporate finance and explore the tools used to address these questions. Instructor: Staff. 3 units.

553. Corporate Finance Theory - Finance III. This course looks at the foundations of the theory in corporate finance. Topics covered include adverse selection, contracting and agency problems, capital structure, initial public offerings, collateral and corporate finance, bubbles and corporate financing decisions, banking and bank runs, and coordination failures. Applications in corporate finance include optimal capital structure, voting, debt regeneration, investment decisions and market valuation, executive compensation, bank runs, initial public offerings, and secondary public offerings, collateralization and securitization. Instructor: Staff. 3 units.

554. Asset Pricing - Finance IV. This course covers central issues in the field of Asset Pricing. Topics covered in the course include (i) state price representation of dynamic asset pricing models; (ii) present value and its implications for financial markets; (iii) estimation issues in asset pricing; (iv) dynamic consumption based models; (v) dynamic household portfolio choice; (vi) term structure models; (vii) option markets; (viii) production and asset prices; and (ix) recent developments in asset pricing. The course covers many of the recent ideas/articles in asset pricing. Prerequisite: None. Instructor: Staff. 3 units.

561. Seminar in Quantitative Research in Marketing. Research in marketing endeavors to explain consumer and firm behaviors and use these to abet managerial decision making. This course surveys quantitative research in marketing, with a focus on statistical and game-theoretic models. The goal of the course is to a) raise students' awareness of this literature and b) stimulate new research interests. By the end of the course, students should be familiar with the key issues and approaches in quantitative marketing, the strengths of these research streams, and the opportunities to extend them. Instructor: Staff. 3 units.

562. Seminar in Consumer Behavior. Examines the development of research in consumer behavior. Major emphasis is given
to theoretical developments and empirical research, with a range of articles assigned for each topic. Topics include motivation and personality, perceptual processes, information search, choice processes, attitudes and persuasion, learning, and influence in consumer choice. Instructor: Staff. 3 units. C-L: Psychology 315

563. Marketing Models Seminar. The primary goals of this seminar are: (a) to review critically the most current research in marketing and (b) to gain a better understanding of and ability to build one's own model. After taking this course, students should be able to understand the assumptions and mathematical development of the current quantitative work in marketing and to use this understanding to develop meaningful extensions. Instructor: Staff. 3 units.

564. Experimental Design and Analysis Seminar. Examines issues in the design and analysis of experiments. Emphasis on analysis of variance (ANOVA), starting with the basic ANOVA model and examining multiple factor designs, blocking designs, nested models, within subject designs, repeated measure designs, and analysis of covariance. Instructor: Edell Britton. 3 units.

571. Operations Strategy Seminar. Recent developments in the strategy of operations in both the manufacturing and service sectors. Topics include the focused factory concept, Japanese manufacturing philosophy, technological policy toward new process development and toward new product introduction, vertical integration, choice of capacity and location, industry analysis, and the impact of government regulation. Emphasis on the development of hypotheses about strategic topics and the empirical means by which they can be tested. Instructor: Staff. 3 units.

572. Seminar in Operational and Technological Tactics. Current issues in the day-to-day management of manufacturing and service delivery systems. Topics include material requirements planning, capacity requirements planning, quality of work life projects, productivity measurement and enhancement, implementation of new product introductions and production process modifications, quality assurance, production planning and scheduling, and logistics. Concentration on the substance of recent developments, the generation and test of hypotheses about tactical issues, and the applicability of various optimization techniques to the advance of operation tactics. Instructor: Staff. 3 units.

591. Selected Topics in Business. Allows the doctoral student the opportunity to study special topics in management on an occasional basis depending on the availability and interests of students and faculty. Instructor: Staff. Variable credit.

596. Curricular Practical Training. This course offers international students an experiential learning opportunity in a U.S. work environment. A paper will follow the practical training. Instructor: Staff. 1 unit.

597. Dissertation Research. For students actively pursuing research on their dissertation. Credit to be arranged. Prerequisite: student must have passed the preliminary examination and have the consent of the director of the doctoral program and instructor. Instructor: Staff. Variable credit.

598. Independent Study. Allows the doctoral student the opportunity to engage in study or tutorial on special topics on an individual basis under the supervision of a faculty member. Credit to be arranged. Prerequisite: doctoral program standing and consent of the director of the doctoral program and instructor. Instructor: Staff. Variable credit.

599. Directed Research. Allows the doctoral student to engage in individual research projects under the supervision of a faculty member. Credit to be arranged. Prerequisite: doctoral program standing and consent of the director of the doctoral program and instructor. Instructor: Staff. Variable credit.

Canadian Studies

Jane Moss, Director

A certificate is available in this program.

The Canadian Studies Program offers a certificate of graduate study. The requirements for the certificate include completion of three Canadian studies courses, including the core course, Interdisciplinary Studies Course 282, Canadian Issues. The other two courses may be from existing courses, or from independent studies with the center’s faculty. In addition, the dissertation must be written on a Canadian or Canadian-comparative topic. The student must also demonstrate a knowledge of French or one of Canada’s aboriginal languages.

The purpose of the Canadian Studies Program is to formalize and expand the interest of graduate students in Canada, to introduce the study of Canadian life and culture at the undergraduate level, and to encourage such study in primary and secondary schools.

The program awards a limited number of foreign language and area studies graduate fellowships and teaching assistantships for the study of Canada to American residents. Fellows must work on a Canadian or Canadian/comparative dissertation topic within their disciplines and must also study French. Grants of travel aid for field research in Canada are also offered.

The program sponsors lectures by Canadian specialists and supports seminars devoted to Canada. Opportunities for study in Canada are offered to honors undergraduates in Canadian studies, graduates, and faculty.

Requirements:

• Complete three full graduate courses related to Canada, one of which is Interdisciplinary Course 282S.

• Study or demonstrate proficiency in French, a native North American language, or a “heritage language”

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interdisciplinary training programs. For more information, contact the director of graduate studies (see above).

Admission to graduate training in cell biology is through one of these programs, including genetics, cell and molecular biology, developmental biology, neurobiology, pharmacology, cancer biology, and toxicology. The department has excellent facilities, including a state of the art confocal microscopy suite with time-lapse live cell video imaging, Typhoon Trio phosphorimaging station, four-color fluorescent scanning/multiplexing, zebrafish facility, mouse addiction and innate immunity, as well as heart, lung, gut, muscle, and reproductive organ function. The department has developed interests in cellular, organ, and systemic physiology, including neural specification and pathfinding, sex determination, development of the gonad, gut, lung, heart, head and neural tube, and appendage and heart regeneration. Specific interests in cellular, organ, and systemic physiology include neuromuscular junctions, the cellular basis of development of the gonad, gut, lung, heart, head and neural tube, and appendage and heart regeneration.

The Department of Cell Biology participates in several university-wide interdisciplinary training programs, including genetics, cell and molecular biology, developmental biology, neurobiology, pharmacology, cancer biology, biomedical engineering, and toxicology. Admission to graduate training in cell biology is through one of these interdisciplinary training programs. For more information, contact the director of graduate studies (see above).

Cell Biology (CELLBIO)

200. Cell and Tissue Biology. This is the introductory medical school and graduate course in microscopic anatomy. Students participate in lectures and laboratories on the structure and function of cells and tissues of the body. The course provides practical experience in the use of the light microscope analyzing an extensive slide collection of mammalian tissues. 3 credits. McIntosh and staff. 3 units.

201. Microscopic Anatomy. Histology of all major organs of the body. Structure and cell biology at both the level of the light and electron microscope. 3 credits. McIntosh and staff. 3 units.

202. Medical Physiology. Medical and graduate level course on organ and cell physiology. Human and medical aspects are stressed. 4 credits. Anderson and staff. 4 units.

203. Introduction to Physiology. Modern organ physiology; cellular physiology, organ system physiology including cardiovascular, respiratory, renal gastrointestinal, endocrine, reproductive, muscle and nervous. Mini course. Prerequisite: elementary biology. Instructors: Jakoi and Vigna. 3 units.

206. Physiology and Medicine of Extreme Environments. Advanced topics in physiology and medicine of ambient pressure, immersion, gravity, temperature and gas composition. Environments considered include: diving, hyperbaric medicine; hot/cold terrestrial, water operations; microgravity, high-g acceleration; high altitude, space. Basic mechanisms and medical management of: decompression sickness; altitude sickness; hypothermia and hyperthermia; hypoxia; carbon monoxide poisoning; oxygen toxicity. Practical applications: pressure vessel design, operation; life support equipment; cardiorespiratory physiology measurements at low and high pressure; simulated dive and flight (optional). Prerequisites: consent of the course instructor. Instructor: Vann. 3 units.

208. Stem Cell Course. The course is designed for first-year graduate students to learn the fundamentals of stem cell biology and to gain familiarity with current research in the field. The course will be presented in a lecture and discussion format based on the primary literature. Topics include: stem cell concepts, methodologies for stem cell research, embryonic stem cells, adult stem cells, cloning and stem cell reprogramming and clinical applications of stem cell research. Prerequisites: undergraduate level cell biology, molecular biology, and genetics. Instructors: Hogan and Reya. 3 units. C-L: Molecular Cancer Biology 208, Pharmacology and Cancer Biology 208

210. Research Independent Study. Individual Research in a field of special interest under the supervision of a faculty member, the central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Consent of instructor required. Instructor: Staff. Variable credit. C-L: Marine Sciences

241. Cell Biological Processes. This course is a graduate level introduction to the molecular mechanisms that underlie cellular processes and the experimental techniques used in cell biological research. The lectures will address the processes that cells use to organize themselves into tissues and organs, communicate through second messengers, generate specialized
259. Structural Biochemistry II. Structure, function and evolution of copper and iron based respiratory proteins in response to environmental oxygen levels and physiological needs. Lectures and readings on the balance between pathways for metabolic oxygen utilization and alternative disease-causing pathways involving oxidative and nitrosative reactions. Interactive molecular graphics and student presentations supplement text and lectures. Covers molecular adaptations, circulation, allostery, reaction kinetics and thermodynamics, reactive oxygen and nitrogen species, gene expression, blood pathogens, malaria, sickle cell anemia. (Given at Beaufort.) Prerequisites: organic chemistry or consent of instructor. Instructor: C. Bonaventura. 3 units. C-L: Environment 243, Marine Sciences

251. Cell and Molecular Biology. 4 units. C-L: see Cell and Molecular Biology 251

258. Structural Biochemistry I. 2 units. C-L: see Biochemistry 258; also C-L: Cell and Molecular Biology 258, University Program in Genetics 258, Immunology 258, Structural Biology and Biophysics 258, Computational Biology and Bioinformatics 258.

259. Structural Biochemistry II. 2 units. C-L: see Biochemistry 259; also C-L: Immunology 259, Computational Biology and Bioinformatics 259, Structural Biology and Biophysics 259, University Program in Genetics 259.

268. Biochemical Genetics II: From RNA to Protein. 2 units. C-L: see Biochemistry 268; also C-L: Immunology 268, University Program in Genetics 268

280. Student Seminar. Preparation and presentation of seminars to students and faculty on topics of broad interest to cell biology and physiology. Required of Department of Cell Biology students. Instructor: Staff. 1 unit.

282. Mechanisms of Development/Developmental Genetics. Half-semester minicourse targeted to first-year graduate students in the Biological Sciences. Taught sequentially in the Fall semester with Biology 283. Introduces basic concepts of cell specification, morphogenesis, induction, and other mechanisms that enable cells, tissues and organs to assemble the animal. Emphasis is on model organisms, mainly Drosophila, C. elegans, mouse, and zebrafish, where genomics, mutations, gene modifiers, epistasis analyses, gene knockouts, and transgenesis, plus many other genetic approaches have yielded important insights into the differentiation of cells and the development of complex organisms. Cross-listed with Biology 282. Instructors: Kirby, Klingensmith, and McClay. 2 units. C-L: Biology 282

283. Developmental Genetics. Half-semester mini-course targeted to first year graduate students in the Biological Sciences. Taught sequentially in the Fall semester with Biology 282. Focuses on genetic approaches to solve mechanistic problems of development. Emphasis is on model organisms, mainly Drosophila, C. elegans, mouse and zebrafish, where genomics, mutations, gene modifiers, epistasis analyses, gene knockouts, and transgenesis, plus many other genetic approaches have yielded important insights into the differentiation of cell and the development of complex organisms. Cross-listed with Biology 283. Instructors: Kirby, Klingensmith, and McClay. 2 units. C-L: Biology 283

296. Developmental Biology Colloquium. Instructor: Staff. 3 units.

301. Human Structure & Function. Core course of preclinical curriculum presents scientific principles underlying structure and function of the normal human body. Focuses on gross anatomy, microscopic anatomy, and physiology of nine organ systems providing the foundation for the practice of medicine. Registration of non-Pathologist's Assistant students requires permission of Course Director. Instructor: Jakoi and Staff. 12 units.

312. Research. Specific areas of investigation include: membrane structure; extracellular matrix; cell adhesion; cell motility; cytoskeletal elements; chromosome structure and movement; genetics and molecular biology of contractile proteins; muscle ultrastructure; gamete biology; molecular and structural biology of photoreceptors; hormone receptors; cell growth; developmental biology; membrane transport and electrophysiology; metabolism; cardiovascular physiology; microcirculation; hyperbaric physiology; and theoretical studies and computer modeling of physiological processes. Instructor: Staff. Variable credit.

320. Research Problems in Cell Biology. Coverage of selected topics important in current cell biology research. Format includes faculty lectures and directed readings of current research papers presented and discussed by students. Instructor: Hogan and staff. 3 units.

346. The Mouse as a Model Organism. Graduate level introduction to the mouse as a model system. Course will cover embryology, genetics, and molecular manipulation of the mouse embryo. Suitable for students who plan to focus on mouse development and for those who plan to use the mouse to address a biological problem. Minicourse 2nd half-semester. Instructor: Capel. 2 units. C-L: University Program in Genetics 346

417. Cellular Signaling. Mechanism of action of hormones at the cellular level including hormone-receptor interactions, secondary messenger systems for hormones, mechanisms of regulation of hormone responsiveness, regulation of growth, differentiation and proliferation, mechanisms of transport and ion channels, stimulus sensing and transduction. Some lectures stress the clinical correlation of the basic course concepts. Instructor: Caron, Casey, Means, and invited lecturers. 3 units. C-L: Biochemistry 417, Molecular Cancer Biology 417, Pharmacology and Cancer Biology 417

Cell and Molecular Biology
Daniel Lew, Director (Department of Pharmacology and Cancer Biology); Meta Kuehn, Director of Graduate Studies
This is an admitting program.
A certificate is also available in this program.

Research training in cell, developmental, and molecular biology is found in one of eight departments/programs at Duke University: Biochemistry, Biology, Cell Biology, Immunology, Molecular Genetics and Microbiology, Neurobiology, Pathology, and Pharmacology and Cancer Biology. To effectively utilize this broad spectrum of expertise for the training of promising scientists while still providing a coherent curriculum, the Duke University Program in Cell and Molecular Biology has been established, bringing together the research foci of approximately 142 faculty.

The program offers a certificate of graduate studies, with the doctoral degree awarded by the chosen Department. Students admitted to CMB have up to one academic year to affiliate with a degree program. During the first and second years students typically take a selection of courses providing a broad-based approach to key areas of cell and molecular biology, with the specific course selection tailored to the individual student. Research training is stressed throughout the program and dissertation research usually begins by the third semester. Applicants must have demonstrated, in addition to overall academic excellence, a proficiency in the biological and physical sciences.

Certificate Requirements:

CMB students will receive their PhD from the department with which they affiliate and they will receive a certificate in Cell and Molecular Biology for completing the CMB curriculum. The two-year course load totals 24 graded credit units including courses recommended or required by the PhD-granting department.

- Must take CMB 251 earning eight units of credit
- Must take CMB 264 seminar course earning eight units of credit
- Six modules in first semester in areas such as cell, molecular, and organismal biology, emphasizing critical review of the primary literature ad well as modules specializing in modern tools of the trade like microscopy, statistics, and bioinformatics.

For additional information, please visit our Web site, [http://cmb.duke.edu/educational/certificate.html](http://cmb.duke.edu/educational/certificate.html) or e-mail to: rdrol.richardsom@duke.edu.

**Cell and Molecular Biology Courses (CMB)**


258. **Structural Biochemistry I.** 2 units. C-L: see Biochemistry 258; also C-L: Cell Biology 258, University Program in Genetics 258, Immunology 258, Structural Biology and Biophysics 258, Computational Biology and Bioinformatics 258

264. **Cell and Molecular Biology Colloquium.** Required of all CMB students. Presentations by upper-year students: one student talks about ongoing dissertation research and another introduces a research paper relevant to that week's seminar. Students attend the Thursday seminar (Cell Structure and Function) and can have lunch with the speaker. Credit is based on attendance. Instructor: Kuehn. 2 units.

297. **Modern Techniques in Molecular Biology.** Fundamental laboratory techniques in basic research in two sections: 1. protein purification, analysis, and the study of protein interactions; 2. nucleic acid techniques, a review of basic nucleic acid chemistry, enzymatic modification, qualitative and quantitative PCR, DNA sequencing, cloning, vectors, and expression analysis including microarray techniques. A team-based learning model: course reading material and recorded lectures are reviewed before class, while in class the material is reinforced through problem sets and group discussion. Consent of instructor required for undergraduates. First half of fall semester. Instructor: Datto. 2 units.

333. **Statistics for Basic Biomedical Scientists.** 2 units. C-L: see Pharmacology and Cancer Biology 333; also C-L: Neurobiology 333

378. **Genetic Approaches to the Solution of Biological Problems.** 4 units. C-L: see University Program in Genetics 378; also C-L: Molec Genetics & Microbiology 378, Biology 378

**Chemistry**

Professor Warren, *Chair* (5311 French Family Science Center); Professor Baldwin, *Director of Graduate Studies* (1101 FFSC); Professors Agre, Baldwin, Beratan, Bonk, Crumbliss, McCafferty, McLendon, Reichert, Shaw, Simon, Therien, Toone, Warren, Widenhoefer, Yang; Associate Professors Craig, Fitzgerald, Franz, Liu, MacPhail, Oas; Assistant Professors Charbonneau, Collart, Hong, Wiley, Zhou; Professors Emeriti Arnett, Chesnut, Lochner, McPhail, Palmer, Quin, Smith, Wells, and Wilder

The Department of Chemistry offers graduate work leading to the PhD degree.

While students are normally admitted only to the PhD program, some students do ultimately pursue an MS degree. Entering graduate students should normally have taken an undergraduate degree in chemistry, along with related work in mathematics and physics. Graduate courses are offered in the fields of analytical, biological, inorganic, organic,
Students will complete 22 units of graded course work by the end of the fall semester of the second year of residence. Normally, students will complete a minimum of 12 units during their first semester, along with the research orientation seminar (CHEM 377). Courses from outside the department may be substituted for chemistry graduate courses, with permission of the director of graduate studies.

Further details concerning the general departmental program, admissions, departmental facilities, the faculty, ongoing research, and financial support may be obtained from the director of graduate studies, e-mail: dgst@chem.duke.edu, or our Web site at: http://www.chem.duke.edu/.

Chemistry (CHEM)

275. Advanced Studies. (1) Analytical chemistry, (2) inorganic chemistry, (3) organic chemistry, and (4) physical chemistry. Open to especially well-prepared undergraduates by consent of director of undergraduate studies. Instructor: Staff. 3 units.

276. Advanced Studies. Same as Chemistry 275, except carries only half course credit. Instructor: Staff. 2 units.

301. Analytical Chemistry. Fundamental considerations of chemical measurements, optical spectroscopy, mass spectrometry, and separation methods. Instructors: Fitzgerald. 4 units.

302. Spectrochemical Analysis. Advanced topics in spectroscopic analysis, emphasizing absorption, emission, and luminescence techniques and applications to biomolecules. Prerequisite: Chemistry 301 or consent of instructor. Instructor: Staff. 2 units.

304. Separation Science. Fundamental separation chemistry, practical aspects of chromatographic methods, larger scale processes. Prerequisite: Chemistry 301 or consent of instructor. Instructor: Staff. 2 units.

306. Biomolecular Mass Spectrometry. Advanced topics in the mass spectral characterization of biopolymers with an emphasis on protein and DNA analysis. Fundamental and practical aspects of the ionization processes and the instrumentation associated with MALDI- and ESI-Mass spectrometry discussed along with applications of these techniques to structural problems in chemistry and biochemistry. Prerequisite: Chemistry 301 or consent of instructor. Instructor Fitzgerald. 2 units.

307. Biosensors. Biosensors (GE, IM, MC). Biosensors are defined as the use of biospecific recognition mechanisms in the detection of analyte concentration. The basic principles of protein binding with specific reference to enzyme-substrate, lectin-sugar, antibody-antigen, and receptor-transmitting binding. Simple surface diffusion and absorption physics at surfaces with particular attention paid to surface binding phenomena. Optical, electrochemical, gravimetric, and thermal transduction mechanisms which form the basis of the sensor design. Prerequisites: Biomedical Engineering 83L and 100L or their equivalent and consent of instructor. Instructors: Reichert or Vo-dinh. 3 units.

309. Special Topics in Analytical Chemistry. An advanced treatment of important areas in modern analysis. Topics may include: electrochemistry, small computer applications, magnetic resonance, and problem-solving approaches. 1 to 4 units.

310. Spectroscopy and Molecular Structure. The application of chemical concepts and methods to solving problems in molecular and cell biology, with emphasis on the use of small molecules to elucidate and control information transfer in biological systems. Provides
relevant background on both useful chemical tools and new biological targets. Instructors: Hong, Toone, McCafferty. 4 units.

319. Special Topics in Biological Chemistry. Advanced topics and recent developments in biological chemistry. 1 to 4 units. Instructor: Staff. Variable credit.

320. Physical Methods in Inorganic Chemistry. Physical methods covered include paramagnetic NMR, EPR, magnetism, NQR, Mossbauer spectroscopy, photoelectron spectroscopy, and x-ray analysis. Instructor: Staff. 2 units.

321. Inorganic Chemistry. Bonding and spectroscopy, reactions, transition metal chemistry, main group chemistry, organometallics/catalysis, and solid state. Instructors: Franz. 4 units.

322. Chemical Applications of Group Theory Including Spectroscopy. Topics covered include symmetry, point groups, group theory, character tables, electronic absorption spectroscopy, infrared spectroscopy, Raman spectroscopy, and microwave spectroscopy. Instructors: Simon and Warren. 2 units.

324. Bioinorganic Chemistry. Topics covered include metal activated enzymes in hydrolysis, oxygen carriers, nitrogen fixation, iron storage and transport, photosynthesis, protein electron transfer, and DNA mediated electron transfer. Instructors: Crumbliss, Therien, and Franz. Variable credit.


329. Special Topics in Inorganic Chemistry. Lectures, oral reports, and discussions on advanced topics and recent advances in the field of inorganic chemistry. Topics may include: bioinorganic chemistry, fluxional molecules, homogeneous catalysis, synthesis and properties of selected groups of compounds, and new physical methods. 1 to 4 units. Topics course. Instructor: Staff. Variable credit.

331. Organic Chemistry. Bonding and structure, stereochemistry, conformational analysis, substitution, addition, and elimination reactions, carbon reactive intermediates, concerted reactions, photochemistry, carbon allylation, carbonyl addition nucleophilic substitution, electrophilic additions, reduction, cycloadditions, rearrangements, main group organometallics, oxidation. Instructors: Baldwin, Coltart, Craig, Hong, Toone, and Widenhoefer. 4 units.

332. Organic Synthesis. Synthetic design, retrosynthetic analysis, synthetic methods, total syntheses. Instructors: Baldwin, Coltart, Hong, and Widenhoefer. 4 units.


335. Advances in Photonics: An Overview of State-of-the-Art Techniques and Applications. 3 units. C-L: see Biomedical Engineering 335

336. Bioorganic Chemistry. Basic enzymology, mechanisms of enzymatic reactions, cofactors, oxidoreductases, C1 chemistry, carbon-carbon bond formation, carboxylation/decarboxylation, heme, pyridoxal enzymes, thiamine enzymes. Prerequisite: Chemistry 331 or equivalent. Instructor: Toone. 4 units. C-L: Biochemistry 336


339A. Special Topics in Organic Chemistry. Advanced topics and recent developments in organic chemistry. Instructor: Staff. Variable credit.

339B. Special Topics in Organic Chemistry. Advanced topics and recent developments in organic chemistry. Instructor: Staff. Variable credit.


342. Quantum Mechanics. Special emphasis on chemical applications. Topics include: linear algebra, the uncertainty relations, angular momentum, perturbation theory, time-dependent phenomena, molecules in electromagnetic fields, group theory, and electron correlation. Prerequisite: Chemistry 341 or consent of instructor. Instructors: Beratan, Liu, MacPhail, Simon, and Yang. 4 units.

343. Statistical Thermodynamics. Introduction to statistical thermodynamics, with an emphasis on ideal systems and selected model approaches to more complex systems, for example, lattice models. Instructors: Beratan, Charbonneau, MacPhail, and Yang. 2 units.
344. **Statistical Mechanics.** Fundamentals of quantum and classical statistical mechanics using the ensemble approach. Introduction of modern techniques and applications including the renormalization group treatment of phase transitions and linear response theory of time-dependent statistical mechanics. Prerequisite: Chemistry 343 or consent of instructor. Instructors: Beratan, Charbonneau, MacPhail, and Yang. 4 units.

345. **Kinetics.** The phenomenology and theory of chemical dynamics and reaction rates. Instructors: Beratan, Liu, MacPhail, and Simon, and Warren. 2 units.

346. **Biophysical Chemistry.** The interrelationships between structure, function, and mechanisms of biological macromolecules. Principles of dynamics, including kinetics, reactivity and transport, and structure, including thermodynamics, NMR, fluorescence, and CD spectroscopy. Instructors: Beratan, Ous, Shaw, Simon, and Warren. 4 units.


349A. **Special Topics in Physical Chemistry.** Presentation of one or more topics of interest such as advanced methods in crystallography, light scattering and small angle X-ray diffraction application of ESR spectroscopy to chemical problems, electronic spectroscopy of proteins group theory intermolecular forces, liquid crystals, methods or determining the rates of elementary steps in reaction kinetics, physical chemistry of aerosols, physical-chemical methods of polymer characterization, structure and bonding in metal-enzymes, statistical mechanics of fluids, topics in structural chemistry, and triplet excitons. Variable credit. Instructor: Staff. Variable credit.

349B. **Special Topics in Physical Chemistry.** Presentation of one or more topics of interest such as advanced methods in crystallography, light scattering and small angle X-ray diffraction application of ESR spectroscopy to chemical problems, electronic spectroscopy of proteins group theory intermolecular forces, liquid crystals, methods or determining the rates of elementary steps in reaction kinetics, physical chemistry of aerosols, physical-chemical methods of polymer characterization, structure and bonding in metal-enzymes, statistical mechanics of fluids, topics in structural chemistry, and triplet excitons. Variable credit. Instructor: Staff. Variable credit.

373. **Seminar.** One hour a week discussion. Credit/no credit grading only. Instructors: All members of the graduate staff. 1 unit.

374. **Seminar.** One hour a week discussion. Credit/no credit grading only. Instructors: All members of the graduate staff. 1 unit.

375. **Research.** Instruction in methods used in the investigation of original problems. Individual work and conferences. 1 to 6 units each. Instructors: All members of the graduate staff. Variable credit.

376. **Research.** Instruction in methods used in the investigation of original problems. Individual work and conferences. 1 to 6 units each. Instructors: All members of the graduate staff. Variable credit.

377. **Research Orientation Seminar.** A survey of departmental research. Required of all entering graduate students in chemistry. Consent of director of graduate studies required. Instructors: All members of the graduate staff. 1 unit.

380. **Graduate Training Internship.** Designed to allow graduate student in Chemistry to engage in internship lab work and doctoral study with external agencies and institutions for credit, when determined necessary for degree completion. Laboratory work and analysis can be conducted at external institution with permission of immediate faculty supervisor. Permission of instructor required. Instructor: Staff. 1 unit.

**Classical Studies**

Professor Boatwright, *Chair* 231 Allen; Associate Professor Woods, *Director of Graduate Studies* (233C Allen); Professors Antonaccio, Boatwright, Burian, Davis; Associate Professors Janan, Johnson, Sosin, Woods; Assistant Professors Atkins and González; Professors Emeriti Clay, Newton, Richardson, Rigsby, Stanley; Research Professor Euben; Adjunct Associate Professor Dillon (Art, Art History and Visual Studies)  

The Department of Classical Studies offers graduate work leading to the PhD degree in classical studies.

Work in the department encompasses all aspects of the Greco-Roman world: students in the program are able, through course work, directed research, and their own teaching, to prepare for careers of teaching and research as broadly trained classical scholars. For regular admission, students should offer at least three years of college study in one of the classical languages and two in the other. Before developing a specialization within the program, students are expected to acquire facility in both Greek and Latin, a broad knowledge of the literatures and of ancient history and archaeology, and command of research methods. Reading knowledge of French and German is required for the PhD. There are no specific course requirements for the PhD in classical studies, but students normally complete their coursework by the end of the fifth semester. The resources of the department include important collections of Greek and Latin manuscripts and papyri, and a study collection of Greek and Roman art.

For additional information and further details on graduate courses offered, visit our Web site: [http://classicalstudies.duke.edu](http://classicalstudies.duke.edu).

**CLASSICAL STUDIES (CLST)**

203. **Ancient Political Philosophy (C-N).** 3 units. C-L: see Political Science 223
207. Ancient Greek Religion: 1200 - 300 B.C. Greek religion from the Bronze Age to the Hellenistic period through literary, epigraphic, and archaeological sources. Prerequisite: some background in Greek history, art, or myth. Consent of instructor required. Instructor: Antonaccio or staff. 3 units.

211S. Plato. 3 units. C-L: see Philosophy 211S

212S. Greek History from the Bronze Age to the fifth century BCE. Study of Greek history from the Bronze Age to the fifth century BCE via survey, case-studies, or a combination of both. Offerings might include Fifth-century Greece, Archaic Greece, The Athenian Empire, Western Greeks, Ancient Democracy, vel sim. Instructor: Staff. 3 units.

213S. Greek History: Fifth through first centuries BC. Studies in later Greek History from the fifth through first centuries BC. Coverage within these chronological boundaries via survey, case-studies, or a combination of both. Offerings might include Fourth-century Greece, The Hellenistic World, Ptolemaic Egypt, vel sim. Instructor: Sosin. 3 units.

214S. Roman History from Romulus to Augustus. Study of Roman history from its earliest beginnings to the age of Augustus. Coverage via survey, case-studies, or a combination of both. Offerings might include The Roman Republic, Conflict of the Orders, Roman Revolution, vel sim. Instructor: Boatwright. 3 units.

215S. Roman History from Augustus through Late Antiquity. Study of Roman history from Augustus to the early medieval period via survey, case-studies, or a combination of both. Offerings might include The Roman Empire, The Julio-Claudians, The Second Sophistic, The Severans, The Third-Century Crisis, Late Antiquity, vel sim. Instructor: Staff. 3 units.

217S. Aristotle. 3 units. C-L: see Philosophy 217S

220S. Greek Art and Society: Archaic To Classical. 3 units. C-L: see Art History 201S

221. Archaic Greece. Greece and the Near East from the end of the Bronze Age to the Persian Wars. Instructor: Antonaccio. 3 units. C-L: History 259

224. The Roman Republic. The rise of Rome, to its mastery of the Mediterranean; the political, social, and cultural consequences. Instructor: Boatwright. 3 units. C-L: History 263

225. The Roman Empire. The foundation, consolidation, and transformation of Roman rule from Augustus to Diocletian. Instructor: Boatwright. 3 units. C-L: History 264

228. The Legacy of Greece and Rome. The reception of classical antiquity--its literature, art and architecture--in subsequent ages, from the early medieval period to the present day. Instructor: Woods. 3 units. C-L: Medieval and Renaissance Studies 228

231S. Greek Sculpture. Free-standing, relief, and architectural sculpture from the Archaic period to the Hellenistic age, representing changing aesthetic, social, and political aims. Instructor: Dillon. 3 units. C-L: Art History 238S

232S. Greek Painting. From the Late Bronze Age to the fourth century B.C. with emphasis on archaic and classical Athenian vase painters. Instructor: Staff. 3 units. C-L: Art History 237S

236S. Roman Painting. Techniques, iconography, and use in decoration. Instructor: Staff. 3 units. C-L: Art History 227S

240. Greek Art and Society: Hellenistic. 3 units. C-L: see Art History 204S

240S. Live Images: Ancient and Medieval Representations of the Divine. 3 units. C-L: see Visual Studies 233S; also C-L: Religion 233S, Medieval and Renaissance Studies 233S

301. Proseminar: Introduction to Classical Studies. Credit/no credit grading only. Instructor: Staff. 3 units.

311. Archaeology Seminar I. Selected topics. Instructor: Antonaccio or staff. 3 units.

312. Archaeology Seminar II. Selected topics. Instructor: Antonaccio or staff. 3 units.

321. Seminar in Ancient History I. Selected topics. Instructor: Boatwright or Sosin. 3 units.

322. Seminar in Ancient History II. Selected topics. Instructor: Boatwright or Sosin. 3 units.

395. Special Topics in Classical Studies. Special Topics in Classical Studies. Topics vary by semester. Instructor: Antonaccio or staff. 3 units.

399. Directed Reading and Research. Credit to be arranged. Instructor: Staff. Variable credit.

GREEK (GREEK)

200. Survey of Greek Literature. Instructor: Staff. 3 units.

201. Readings in Greek Literature. Instructor: Staff. 3 units.

203. Epic and Lyric. Readings in Greek epic and/or Lyric, with attention to language, meter, poetics, characterization, narrative structure, ancient and modern interpretation, traditions beyond Greece and Rome, epic poems as codifiers of socially constructed cultural norms, lyric construction, and examination of Greek cultural identity. Authors and works might include selections of fragmentary works, Pindar, Bacchylides, Callimachus, Theocritus, the Greek Anthology, and others. Instructor: Burian or González. 3 units.

204S. Rhetoric, Literary Criticism and Philosophy. Readings of rhetorical speeches and treatises (e.g. Demosthenes, Isocrates, Aristotle's Rhetoric, Rhetorica ad Alexandrum); and/or of ancient literary criticism (e.g. Aristotle, Ps.-Longinus); and/or of philosophical works (e.g. Plato's Dialogues, fragments of the pre-Socratics); and/or of authors, works, trends in Greek literature of the Roman Empire. Instructors: Burian, Gonzalez or Staff. 3 units.


207. Drama. Readings in the dramatic and mimetic genres, especially Attic Tragedy and Comedy, with attention to language, meter, staging, characteristic themes and conventions, and especially the cultural context of ancient drama and its use as an instrument of public ethical and political debate. Authors may include Aeschylus, Sophocles, Euripides, Aristophanes, Menander, Sophron, Herodas, Lycophron. Instructor: Burian. 3 units.

222. Historiography. Investigation of the Greek concept and practice of writing history from Atthis to Agathius, with attention to key themes, periods, historiographical conventions. Authors and works might include Herodotus, Thucydides, Xenophon, Polybius, Diodorus Siculus, Arrian, Appian, Eusebius,Procopius, Agathius. Instructor: Sosin or staff. 3 units.

280S. Greek Epigraphy. Introduction to the field of Greek Epigraphy, its history, methods, and place within the field of Classical Studies. Close attention to reading and translation of the variety of inscribed documentary and literary Greek. Instructor: Sosin. 3 units.

281S. Papyrology. Introduction to the field of Greek Papyrology, its history, methods and place within the field of Classical Studies. Close attention to reading and translation of the variety of documentary and/or literary papyrological Greek. Instructor: Sosin or staff. 3 units.

301. Seminar in Greek Literature I. Selected authors and topics. Instructor: Burian or González. 3 units.

302S. Seminar in Greek Literature II. Broader themes in Greek Literature. Offerings might focus on themes such as Ancient Scholarship, Praise and Blame, Early Christian Authors. Instructor: Gonzalez. 3 units.

399. Directed Reading and Research. Instructor: Staff. Variable credit.

LATIN (LATIN)

201. Survey of Latin Literature from its Beginnings to Late Antiquity. Instructor: Staff. 3 units.

202S. Selections from Latin texts/authors in the genres of History, Oratory and/or Philosophy. Detailed study of selections from one or more genres. Typical iterations might investigate Roman concept and practice of writing history from Cato to Ammianus Marcellinus; study of Roman oratory (readings might include Cicero, Quintilian, Tacitus); and/or philosophical texts (readings might include Lucretius, Seneca, Pliny the Elder, Vitruvius, Augustine, Boethius). Instructor: Boatwright or Staff. 3 units.

205S. Selections from Latin texts/authors in the genres of Drama, Satire and/or the Novel. Detailed study of selections from one or more of the genres Drama, Satire, Novel. Authors and readings might include Plautus, Terence, Seneca, Horace, Persius, Juvenal, Petronius, Apuleius. Instructor: Davis, Janan or Staff. 3 units.

217S. Latin Prose Syntax and Style. Latin prose composition combined with analysis of the style and syntax of select Latin prose authors. Instructor: Staff. 3 units.

240S. Special Topics in Latin Literature of the Middle Ages and Renaissance. Topics change each semester offered. Instructor: Woods or staff. 3 units. C-L: Medieval and Renaissance Studies 239S

284S. Latin Palaeography. Introduction to the field of Latin Palaeography, its history and methods; also the role of the book in the intellectual life of the medieval and Renaissance periods. Particular emphasis placed on learning to read Latin scripts from antiquity to the Renaissance. Instructor: Woods. 3 units. C-L: Medieval and Renaissance Studies 284S

301. Seminar in Latin Literature I. Selected authors and topics. Instructor: Boatwright, Davis, Janan, or Woods. 3 units.

302. Seminar in Latin Literature II. Selected authors and topics. Instructor: Boatwright, Davis, Janan, or Woods. 3 units.

399. Directed Reading and Research. Credit to be arranged. Instructor: Staff. Variable credit.

Cognitive Neuroscience

Associate Professor Brannon, Director of Graduate Studies (B248A Levine Science Research Center)

This is an admitting program.

A certificate is also available in this program.

Students interested in graduate training in cognitive neuroscience should apply to the Graduate Program in Cognitive Neuroscience (CN). Cognitive neuroscience uses the techniques and principles of neuroscience to understand the neural and psychological mechanisms that underlie cognitive processes such as attention, perception, memory, decision making, motor control, conscious awareness, and many others. The CN program is a graduate admitting program designed for students who are interested in broad training that integrates ideas and techniques across this diverse and rapidly growing field. Research experience will provide expertise in the major methods that drive cognitive brain research. Program faculty are drawn from a wide range of departments and programs including Psychology and Neuroscience, Neurobiology, Psychiatry, Biomedical Engineering, Philosophy, Evolutionary Anthropology, Computer Science, Linguistics, Neurology, and Radiology.

Students who matriculate to the CN admitting program do not initially affiliate with any particular department or advisor. They begin by completing broad coursework and laboratory research rotations within the umbrella of the CN program. Typical early coursework includes a proseminar sequence in cognitive neuroscience, lectures and workshops in neurobiology, and seminars on core methods for measuring brain function. During their first year, students complete rotations in three laboratories, often chosen because they investigate different research topics or use diverse research methods. During the second year in the program, students select a primary advisor and declare a
department with which they will affiliate and complete their degree. Students typically also select a secondary advisor who provides complementary expertise in a relevant research topic. After the degree-granting department has been selected, students become full members of that department, while also remaining affiliated with the CN program and participating in its activities. The doctoral degree that is eventually obtained consists of a PhD in the field of the selected department, with a concentration in Cognitive Neuroscience.

CERTIFICATE in COGNITIVE NEUROSCIENCE

Students who matriculate directly into a degree-granting departmental program also have the opportunity to acquire training in cognitive neuroscience at Duke by means of a certificate program in the field. This program is designed for students whose interests are more focused on studies present within a particular department, but who want to also include training in cognitive neuroscience in their graduate program. In addition to the curricular requirements of their home department, students in the certificate program complete a year-long core course in cognitive neuroscience, one independent study in a research lab in cognitive neuroscience, and participate in relevant seminars and journal clubs. To enroll in the Cognitive Neuroscience Certificate Program, students must first be admitted to one of the participating departments (see each Department’s listing for additional information) and then contact the CN Director of Graduate Studies.

Certificate Requirements:

• Must first be admitted to a participating department, i.e., Psychology and Neuroscience, Neurobiology, Philosophy, Computer Science, Evolutionary Anthropology, or Biomedical Engineering. For information regarding application to the above departments see their individual Web sites.

• Must complete a year-long core course in Cognitive Neuroscience.

• Participate in relevant seminars and journal clubs.

• Complete curricular requirements of their home department.

For additional information and updated instructions, visit our Web site at http://www.mind.duke.edu/.

Computational Biology and Bioinformatics

John Harer, Director (Department of Mathematics); Jeanette McCarthy, Director of Graduate Studies (Community and Family Medicine); 54 participating faculty

A PhD and a certificate are available in this program.

The Duke University PhD Program in Computational Biology and Bioinformatics (CBB) is an innovative degree program designed to provide rigorous training at the interface of the quantitative and biological sciences. CBB students receive their training both in the classroom and while engaged in original research projects under the supervision of Program faculty, who represent over fifteen departments spanning the biological and computational disciplines in both the medical and non-medical sides of campus.

The CBB program is explicitly designed to be responsive to the breadth and rapidly evolving nature of the CBB arena. To this end, the curriculum is flexible and tailored to the needs and interests of each student through regular meetings with the Student Advisory Committee, consisting of faculty experts in all areas of computational biology on campus.

The CBB core curriculum emphasizes the integration of biology and computation. This integration is reflected in the syllabus of each core course, including lectures on biological applications of the quantitative principles being discussed. The core courses, which are taken by most CBB students, include Computational Biology and Bioinformatics 220, Computational Biology and Bioinformatics 240, and one of Computational Biology and Bioinformatics 261-263. In addition to the core courses, all CBB graduate students are expected to take several elective courses, both within CBB and outside the program in their chosen areas of biological and quantitative expertise. In addition, all first- and second-year students must register for Computational Biology Seminar (Computational Biology and Bioinformatics 210).

Along with this didactic training, faculty supervised research is an integral component of the training program. This begins in the first year when students join faculty-lead research groups for a period of one semester. These research rotations introduce the student to new research problems and methods in an immersive environment where they can obtain original research results and meet other members of the group. Trainees conduct three or four research rotations in their first year of study and join a group by the end of the fall semester of their second year.

For additional information, visit the Web site: http://www.genome.duke.edu/CBB/ or e-mail the CBB Program at cbbdgs@duke.edu.

CERTIFICATE in COMPUTATIONAL BIOLOGY & BIOINFORMATICS

The Certificate Program in Computational Biology and Bioinformatics is intended for Duke students enrolled in departmental PhD programs who wish to expand their current studies to apply to or include the fields of
computational biology and bioinformatics. A student may qualify for the certificate program after completing the following course of study: two out of the three core courses (Computational Biology and Bioinformatics 220, 240, or 261-263); one additional Computational Biology and Bioinformatics course and registration for Computational Biology and Bioinformatics 210 every semester except the semester of graduation.

**Certificate Requirements:**
Students enrolled in departmental MS or PhD programs must complete:
- Two of the three Computational Biology and Bioinformatics core courses (for grades).
- Two additional Computational Biology and Bioinformatics course (for grades).
- Register for CBB210, Computational Biology and Bioinformatics Seminar, every semester except the semester of graduation.
- Appoint at least one member of the Computational Biology and Bioinformatics faculty to their dissertation committee.

**Computational Biology and Bioinformatics Courses (CBB)**

200. Independent Study. Faculty directed experimental or theoretical research. Instructor: Staff. Variable credit.

209. Special Topics in Computational Biology. Instructor: Staff. 3 units.

210S. Computational Biology Seminar. A weekly series of seminars on topics in computational biology presented by invited speakers, Duke faculty and CBB doctoral and certificate students. This course is required for all first and second year CBB students. In addition, all certificate students must register and receive credit for the seminar for four semesters. 1 unit.

211. Journal Club/Research in Progress. A weekly series of discussions led by students that focus on current topics in computational biology. Topics of discussion may come form recent or seminal publications in computational biology or from research interests currently being pursued by students. First and second year CBB doctoral and certificate students are strongly encouraged to attend as well as any student interested in learning more about the new field of computational biology. Instructor: Furey. 1 unit.

212. Responsible Genomics. Selected advanced topics. Instructor: Staff. 3 units.

220. Genome Tools and Technologies. This course introduces the laboratory and computational methodologies for genetic and protein sequencing, mapping and expression measurement. Instructor: Dietrich. 3 units.

221. Computational Gene Expression Analysis. This course covers topics spanning the technological and computational areas of modern gene expression analysis, developing computational methods in important and current problems of clinical and physiological phenotyping, including custom computation and algorithmic development. Prerequisites: Statistics 213, or 214 or 216. Instructor: Staff. 1 unit. C-L: Statistical Science 278, Molec Genetics & Microbiology 221

222. Genome Science & Technology Lab (GE, MC). Variable credit. C-L: see Biomedical Engineering 258L

223. Computational Immunology. Course will integrate empirical and computational perspectives on immunology and host defense. Students are expected to have significant preparation in either biomedicine or a quantitative science. Topics covered are intended to provide an entre into the use of computational methods for research and practice in immunology and infectious disease, from basic science to medical applications. Consent of instructor required. Instructors: Kepler and Cowell. 3 units. C-L: Immunology 213S

224. Differential Expression Proteomics. This course is designed to train and carry out a quantatative differential expression proteomics experiment. The course materials will provide an overview of the fundamentals of protein chemistry and mass spectrometry, as well as detailed information on LC/MS/MS methods for both open platform (‘omic) proteomics experiments for biomarker discovery, and targeted LC/MS/MS methods (Mass Spec “Westerns”) for biomarker verification/validation. Emphasis will be placed QC metrics and commercial and open source bioinformatics tools for bioinformatic data interpretation. Instructor: Moseley. 1 unit.

225. Core Concepts Bridging Genomic and Computational Biology. Advances in the biological sciences are often the result of multi-disciplinary teams of investigators. Successful collaboration requires effective communication, which in turn is facilitated by the construction of a hierarchical "concept map" that spans both disciplines and can be used as the basis of new shared insights and analysis. This course will use important publications that resulted from the successful alignment of biological and computational investigations to help students develop such concept maps and use them to enhance their cross-disciplinary communication. At each session, two faculty representing the appropriate disciplines will be present. Instructor: Staff. 2 units.

230S. Modeling of Biological Systems. 3 units. C-L: see Mathematics 214S; also C-L: Modeling Biological Systems 214S

233. Data-Intensive Computing Systems. 3 units. C-L: see Computer Science 216; also C-L: Computational Biology and Bioinformatics 265

234. Computational Geometry. 3 units. C-L: see Computer Science 234; also C-L: Computational Biology and Bioinformatics 264

240. Statistical Methods for Computational Biology. Methods of statistical inference and stochastic modeling with
statistical theory underlying sequence analysis and database searching; Markov models; elements of Bayesian and likelihood inference; multivariate high-dimensional regression models, applied linear regress analysis; discrete data models; multivariate data decomposition methods (PCA, clustering, multi-dimensional scaling); software tools for statistical computing. Prerequisites: multivariate calculus, linear algebra and Statistics 213. Instructor: Mukherjee. 3 units. C-L: Statistical Science 270

241. Statistical Genetics. Mechanisms, probability models and statistical analysis in examples of classical and population genetics, aimed at covering the basic quantitative concepts and tools for biological scientists. This module will serve as a primer in basic statistics for genomics, also involving computing and computation using standard languages. Instructor: Staff. 3 units. C-L: Statistical Science 271

250. Computational Structural Biology. 3 units. C-L: see Computer Science 263B; also C-L: Statistical Science 277

252. Structure of Biological Macromolecules. 3 units. C-L: see Biochemistry 222; also C-L: Structural Biology and Biophysics 222

258. Structural Biochemistry I. 2 units. C-L: see Biochemistry 258; also C-L: Cell and Molecular Biology 258, Cell Biology 258, University Program in Genetics 258, Immunology 258, Structural Biology and Biophysics 258

259. Structural Biochemistry II. 2 units. C-L: see Biochemistry 259; also C-L: Cell Biology 259, Immunology 259, Structural Biology and Biophysics 259, University Program in Genetics 259

261. Computational Sequence Biology. 3 units. C-L: see Computer Science 261

262. Computational Systems Biology. 3 units. C-L: see Computer Science 262

263. Algorithms in Structural Biology and Biophysics. 3 units. C-L: see Computer Science 263; also C-L: Structural Biology and Biophysics 263

300. Internship. Student gains practical experience by taking an intership in industry, and writes a report about this experience. Requires prior consent from the student's advisor and from the Director of Graduate Studies. May be repeated with consent of the advisor and the Director of Graduate Studies. Credit/no credit grading only. Instructor: Staff. 1 unit.

Computational Science, Engineering, and Medicine

A certificate is available in this program.

The graduate certificate program in Computational Science, Engineering, and Medicine (CSEM) facilitates interdisciplinary training in the use of modern computational techniques in the conduct of research. This broad charter encompasses algorithmic, numerical, and implementation issues. The program is designed for PhD students who have been admitted to one of the participating departments, though applications from terminal MS students who are pursuing a thesis option will be considered. Students will be expected to take credit for three CSEM courses. Additionally, some component of a student’s dissertation or thesis research is expected to involve significant computation, and at least one member of the CSEM-affiliated faculty should serve on the student’s dissertation or thesis committee.

Requirements:

- Designed for PhD students already admitted to a participating department. Terminal MS students pursuing a thesis option may be considered. The application form needs to describe the research project, propose a three-course sequence, and explain how this would broaden the student’s preparation for computationally-oriented research.

  - Complete three CSEM courses for credit.
  - A component of the dissertation or thesis research is expected to involve significant computation.
  - One member of the CSEM primary or affiliated faculty should serve on the student’s dissertation or thesis committee. He/she will assess the computational component of a dissertation or thesis at the proposal state, and at the final exam.

For more information, see the CSEM Web site, http://www.csem.duke.edu/education/grad.html.

Computer Science

Professor Tomasi, Chair (D315 Levine Science Research Center); Associate Professor of the Practice Lucic, Associate Chair (D310 LSRC); Associate Professor J. Yang, Director of Graduate Studies (D327 LSRC); Professors Agarwal, Calderbank, Chase, Donald, Edelsbrunner, Harer, Henriquez, Lebeck, Lenoir, Maggs, Reif, Rose, Sun, Tomasi, and Trivedi; Associate Professors Board, Ferrari, Hartemink, Kedem, Parr, Sorin, and J. Yang; Assistant Professors Babu, Conitzer, Cox, Dwyer, Maggioni, Mukherjee, Munagala, Ohler, Roy Choudhury, and X. Yang; Professors Emeriti Biermann, Ellis, Gallie, Loveland, Patrick, Ramm, Starmer, and Wagner; Professors of the Practice Astrachan and Rodger; Associate Professors of the Practice Forbes and Lucic; Research Professor LaBean; Assistant Research Professor Furey; Adjunct Professors Arge, Lombardi, and Pitsianis; Research Scientist Brady; Adjunct Research Scientists Pormann and Schultes; Lecturer Duvall.

The Department of Computer Science offers programs leading to the MS and PhD degrees in areas of concentration including algorithms, artificial intelligence, scientific computing and numerical analysis, and systems and architecture.
The MS program consists of coursework (30 credits) and a research thesis or project under the supervision of a faculty advisor. The PhD program consists of coursework and a sequence of research milestones culminating in a doctoral dissertation. Course programs for both degrees include a breadth requirement, advanced courses in the declared area of concentration, and two courses in a related field of study. For the PhD program the breadth requirement is satisfied by earning qualifying credit in four of six core areas of subject knowledge. All entering graduate students participate in a special seminar course (Computer Science 300) to introduce them to the discipline and profession of computer science. A student entering graduate study in computer science should have a strong undergraduate grounding in the fundamentals of calculus, linear algebra, and discrete mathematics, and basic knowledge of data structures, assembly language, and one or more higher-level computing programming languages; some undergraduate research experience is preferred. Students should consult the official departmental document Computer Science Graduate Program Degree Requirements for a full explanation of requirements not listed in this bulletin.

Outstanding programs in geometric computing; internet systems, networking and security; biological computing and nanotechnologies; memory systems and massive data management; learning and modeling, computer graphics and visualization, sensor networks, numerical analysis, software engineering, complexity theory, and robotics provide exciting and challenging research opportunities to students in computer science. The research interests of our faculty overlap with these areas and with researcher areas in other disciplines such as biology, engineering, nanotechnology, environmental sciences and medicine.

**Computer Science Courses (COMPSCI)**

210. **Operating Systems.** Fundamental principles of operating system design applied to state-of-the-art computing environments (multiprocessors and distributed systems) including process management (coscheduling and load balancing), shared memory management (data migration and consistency), and distributed file systems. Instructor: Chase, Cox, or Maggs. 3 units.

212. **Distributed Information Systems.** Principles and techniques for sharing information reliably and efficiently in computer networks, ranging from high-speed clusters to global-scale networks (e.g., the Internet). Topics include advanced distributed file systems, distributed programming environments, replication, caching and consistency, transactional concurrency control, reliable update and recovery, and issues of scale and security for Internet information services. Prerequisites: Computer Science 110 or 210 and Computer Science 214, or consent of the instructor. Instructor: Chase, Cox, or Maggs. 3 units.

214. **Computer Networks and Distributed Systems.** Basic systems support for process-to-process communications across a computer network. The TCP/IP protocol suite and the Berkeley sockets application programs interface. Development of network application programs based on the client-server model. Remote procedure call and implementation of remote procedure call. Prerequisite: knowledge of the C programming language. Instructor: Maggs or X. Yang. 3 units.

215. **Wireless Networking and Mobile Computing.** 3 units. C-L: see Electrical and Computer Engineering 256

216. **Data-Intensive Computing Systems.** Data-Intensive Computing Systems. Principles and techniques for making intelligent use of the massive amounts of data being generated in commerce, industry, science, and society. Topics include indexing, query processing, and optimization in large databases, data mining and warehousing, new abstractions and algorithms for parallel and distributed data processing, fault-tolerant and self-tuning data management for cloud computing, and information retrieval and extraction for the Web. Prerequisites: Computer Science 116 or an introductory database course or consent of instructor. Instructor: Babu or J. Yang. 3 units. C-L: Computational Biology and Bioinformatics 233, Computational Biology and Bioinformatics 265

219. **Statistical Data Mining.** 3 units. C-L: see Statistical Science 218

220. **Advanced Computer Architecture I.** Fundamental aspects of advanced computer architecture design and analysis. Topics include processor design, pipelining, superscalar, out-of-order execution, caches (memory hierarchies), virtual memory, storage systems, simulation techniques, technology trends and future challenges. Prerequisite: Computer Science 104 or Electrical and Computer Engineering 152 or equivalent. Instructors: Board, Kedem, Lebeck, or Sorin. 3 units. C-L: Electrical and Computer Engineering 252

221. **Advanced Computer Architecture II.** Parallel computer architecture design and evaluation. Design topics include parallel programming, message passing, shared memory, cache coherence, cache coherence, memory consistency models, symmetric multiprocessors, distributed shared memory, interconnection networks, and synchronization. Evaluation topics include modeling, simulation, and benchmarking. Prerequisite: Computer Science 220 or Electrical and Computer Engineering 252 or consent of instructor. Instructor: Lebeck or Sorin. 3 units. C-L: Electrical and Computer Engineering 259

225. **Fault-Tolerant and Testable Computer Systems.** 3 units. C-L: see Electrical and Computer Engineering 254

230. **Design and Analysis of Algorithms.** Design and analysis of efficient algorithms. Algorithmic paradigms. Applications include sorting, searching, dynamic structures, graph algorithms, randomized algorithms. Computationally hard problems. NP completeness. Prerequisite: Computer Science 100 or equivalent. Instructor: Agarwal, Edelsbrunner, Munagala, or Reif. 3 units.
232. **Approximation Algorithms.** Cover traditional approximation algorithms with combinatorial and linear programming techniques; extended survey of cut problems and metric embeddings; embeddings, dimensionality reduction, locality sensitive hashing, and game theory. Instructor: Agarwal or Munagala. 3 units.

234. **Computational Geometry.** Models of computation and lower-bound techniques; storing and manipulating orthogonal objects; orthogonal and simplex range searching, convex hulls, planar point location, proximity problems, arrangements, linear programming and parametric search technique, probabilistic and incremental algorithms. Prerequisite: Computer Science 230 or equivalent. Instructor: Agarwal or Edelsbrunner. 3 units. C-L: Computational Biology and Bioinformatics 264, Computational Biology and Bioinformatics 265

235. **Topics in Data Compression.** Emphasis on the redundancies found in textual, still-frame images, video, and voice data, and how they can be effectively removed to achieve compression. The compression effects in information processing. Additional topics may include information theory, the vulnerability of compressed data to transmission errors, and the loss of information with respect to the human visual system (for image data). Available compression technologies and the existing compression standards. Prerequisites: Computer Science 130 and 208 or Computer Science 254 or Electrical Engineering 282. Instructor: Reif or Sun. 3 units.

236. **Computational Topology.** Introduction to topology via graphs; facts about curves and surfaces; representing triangulations; discussion of simplicial complexes; emphasis on Delaunay and alpha complexes and on homology groups; computational via matrix reduction; Morse functions; PL functions; Reeb graphs; development of persistent homology; proof of stability; applications and extensions. Prerequisite: Computer Science 230. Instructor: Edelsbrunner or Harer. 3 units. C-L: Mathematics 264

237. **Randomized Algorithms.** Models of computation, Las Vegas and Monte Carlo algorithms, linearity of expectation, Markov and Chebyshev inequalities and their applications, Chernoff bound and its applications, probabilistic methods, expanders, Markov chains and random walk, electric networks and random walks, rapidly mixing Markov chains, randomized data structures, randomized algorithms for graph problems, randomized geometric algorithms, number theoretic algorithms, RSA cryptosystem, derandomization. Prerequisite: Computer Science 230. Instructor: Agarwal, Munagala, or Reif. 3 units.

240. **Computational Complexity.** Turing machines, undecidability, recursive function theory, complexity measures, reduction and completeness, NP, NP-Completeness, co-NP, beyond NP, relativized complexity, circuit complexity, alternation, polynomial time hierarchy, parallel and randomized computation, algebraic methods in complexity theory, communication complexity. Prerequisite: Computer Science 140 or equivalent. Instructor: Agarwal or Reif. 3 units.

250. **Numerical Analysis.** Error analysis, interpolation and spline approximation, numerical differentiation and integration, solutions of linear systems, nonlinear equations, and ordinary differential equations. Prerequisites: knowledge of an algorithmic programming language, intermediate calculus including some differential equations, and Mathematics 104. Instructor: Rose or Sun. 3 units. C-L: Mathematics 221, Statistical Science 250

261. **Computational Sequence Biology.** Introduction to algorithmic and computational issues in analysis of biological sequences: DNA, RNA, and protein. Emphasizes probabilistic approaches and machine learning methods, e.g. Hidden Markov models. Explores applications in genome sequence assembly, protein and DNA homology detection, gene and promoter finding, motif identification, models of regulatory regions, comparative genomics and phylogenetics, RNA structure prediction, post-transcriptional regulation. Prerequisites: basic knowledge algorithmic design (Computer Science 230 or equivalent), probability and statistics (Statistics 213 or equivalent), molecular biology (Biology 118 or equivalent). Alternatively, consent instructor. Instructor: Hartemink or Ohler. 3 units. C-L: Computational Biology and Bioinformatics 261

262. **Computational Systems Biology.** Provides a systematic introduction to algorithmic and computational issues present in the analysis of biological systems. Emphasizes probabilistic approaches and machine learning methods. Explores modeling basic biological processes (e.g., transcription, splicing, localization and transport, translation, replication, cell cycle, protein complexes, evolution) from a systems biology perspective. Lectures and discussions of primary literature. Prerequisites: basic knowledge of algorithm design (Computer Science 230 or equivalent), probability and statistics (Statistics 213 or equivalent), molecular biology (Biology 118 or equivalent), and computer programming. Alternatively, consent of instructor. Instructor: Hartemink or Ohler. 3 units. C-L: Computational Biology and Bioinformatics 262

263. **Algorithms in Structural Biology and Biophysics.** Introduction to algorithmic and computational issues in structural molecular biology and molecular biophysics. Emphasizes geometric algorithms, provable approximation algorithms, computational biophysics, molecular interactions, computational structural biology, proteomics, rational drug design, and protein design. Explores computational methods for discovering new pharmaceuticals, NMR and X-ray data, and protein-ligand docking. Prerequisites: basic knowledge of algorithm design (Computer Science 230 or equivalent), probability and statistics (Statistics 213 or equivalent), molecular biology (Biology 118 or equivalent), and computer programming. Alternatively, consent of instructor. Instructor: Donald. 3 units. C-L: Computational Biology and Bioinformatics 263, Structural Biology and Biophysics 263

263B. **Computational Structural Biology.** Introduction to theory and computation of macromolecular structure. Principles of biopolymer structure: computer representations and database search; molecular dynamics and Monte Carlo simulation; statistical mechanics of protein folding; RNA and protein structure prediction (secondary structure, threading, homology modeling); computer-aided drug design; proteomics; statistical tools (neural networks, HMMs, SVMs). Prerequisites: basic knowledge algorithmic design (Computational Biology and Bioinformatics 230 or equivalent), probability and statistics
296. Advanced Topics in Computer Science. Instructor: Staff. 3 units.

274. Introduction to Computer Vision. Instructor: Parr. 3 units. Prerequisite: Computer Science 100 and Computer Science 130. Image formation and analysis; feature computation and tracking; image motion analysis; stereo vision; image, object, and activity recognition and retrieval. Prerequisites: Mathematics 104 or 107; Statistics 135 or Statistics 104; Computer Science 6. Instructor: Tomasi. 3 units.

296. Advanced Topics in Computer Science. Instructor: Staff. 3 units.

For Graduate Students Only

300. Introduction for Graduate Students in Computer Science. Introduction for graduate students in computer science. Topics for discussion include: computer science as a research discipline, views of what constitutes a research contribution, approaches to research in different subfields, tools and methodologies, publishing and presenting research results, the role of computer science as an "amplifier" in other sciences, ethical and policy issues, the information technology industry, grants and funding, and guidelines for success as a graduate student and as a scientist. Instructor: Staff. 1 unit.

310. Topics in Operating Systems. Not open to students who have taken Computer Science 332. Instructor: Staff. 3 units.

320. Advanced Topics in Digital Systems. 3 units. C-L: see Electrical and Computer Engineering 352

322. Advanced VLSI Design. Theory of advanced VLSI design. Specifications development, methodology, issues, circuit-level trade-offs. Full custom design, standard cell design, gate array design, silicon compilation. Semiconductor technologies and logic families for semi-custom design. Clocking schemes and distribution, race conditions. Design of a variety of circuits (adders, I/O drivers, RAM, FIFO, etc.) Testing of all phases in the life cycle of an integrated circuit. Top-down design and bottom-up implementation. Student projects. Not open to students who have taken Computer Science 310 before Fall 1994. Prerequisite: Electrical Engineering 261 or equivalent. Instructor: Kedem. 3 units. C-L: Electrical and Computer Engineering 361

327. Seminar in Computer Systems Analysis. Topics in computer systems analysis, especially for fault-tolerant systems, including reliability, availability and performance analysis, comparative analysis of architectures, performability, analytic and numerical solution techniques, stochastic Petri nets, simulation. Not open to students who have taken Computer Science 381. 1 to 3 units. Instructor: Trivedi. Variable credit.

331. Operating Systems Theory. Advanced study of theoretical aspects of operating systems emphasizing models and control of concurrent processes, processor scheduling, and memory management. Prerequisite: Computer Science 226 and 231. Instructor: Ellis or Wagner. 3 units.

340. Theory of Computation. Not open to students who have taken Computer Science 325. Instructor: Staff. 3 units.

350. Topics in Numerical Mathematics. Advanced topics in numerical mathematics to be selected from areas of current research. Not open to students who have taken Computer Science 321. Prerequisite: Computer Science 250 and 252. Instructor: Greenside, Rose, or Sun. 3 units.

355. Principles of Research Management. A survey of topics in modern research management techniques that will cover proven successful principles and their application in the areas of research lab organization, resource management, organization of technical projects, team leadership, financial accountability, and professional ethics. Instructor: Staff. 1 unit.

364. Advanced Topics in Nonlinear and Complex Systems. 3 units. C-L: see Physics 313

370. Seminar in Artificial Intelligence. Topics in artificial intelligence, such as natural language understanding, learning, theorem proving and problem solving, search methodologies. Topics will vary from semester to semester. Includes research literature reading with student presentation. Not open to students who have taken Computer Science 382. Instructor: Staff. Variable credit.

376. Advanced Topics in Artificial Intelligence. Course content will vary from year to year and will include a detailed study of one or more of the following: mechanical theorem proving, natural language processing, automatic program synthesis, machine learning and inference, representations of knowledge, languages for artificial intelligence research, artificial sensorimotor systems, and others. Not open to students who have taken Computer Science 315. Prerequisite: Computer Science 270. Instructor: Biemann or Loveland. 3 units.

391. Internship. Student gains practical computer science experience by taking a job in industry, and writes a report about this experience. Requires prior consent from the student's advisor and from the director of graduate studies. May be repeated with consent of the advisor and the director of graduate studies. Credit/no credit grading only. Instructor: Staff. 1 unit.
395. Research. Instruction in methods used in the investigation of original problems. Individual work and conferences. 1 to 6 units. Instructor: All members of the graduate staff. Variable credit.

399. Special Readings. Instructor: Staff. Variable credit.

Cultural Anthropology

Professor Starn, Chair; Associate Professor Meintjes, Director of Graduate Studies; Professors Allison, Baker, Ho, Metory, Nelson, O’Barr, Silverblatt, Starn; Associate Professors Litzinger, Meintjes, Piot, Stein; Assistant Professors Makulu, McIntosh, Subramania; Professors Emeriti Apte, Friedl, Quinn; Secondary Appointments: Professor Andrews (Slavic languages), Mignolo (romance studies), Reddy (history); Associate Professor Tetel (English); Assistant Professors Holsey (African and African American studies), Wilson (women’s studies)

The department offers graduate work leading to the PhD degree in cultural anthropology. It also participates in a program with the Law School leading to a joint JD/MA degree. Students are expected to take an active role in development of their own research goals and plan of study, compiling a portfolio of papers and other writing over the first three years. Requirements include courses in anthropological theory, cross disciplinary course work and spoken and/or written competence in at least one foreign language, at the level appropriate to the planned research program. The core courses include two year-long sequences: Theories in Cultural Anthropology (330S, 331S), required of first-year graduate students, and research/grant writing seminars (332S, 333S), required in the fifth and sixth semesters. Preliminary field research is required in the summer following the second year of classes. The Guidelines for Graduate Students in the Doctoral Program in Cultural Anthropology and the Guidelines for Graduate Students in the JD/MA Program fully describe these and additional requirements and the detailed steps in the student’s graduate career.

Applications for admission to both the PhD and JD/MA programs are accepted every year. Please review the departmental Web site at http://culturalanthropology.duke.edu.

Cultural Anthropology Courses (CULANTH)

200. Duke-Administered Study Abroad: Advanced Special Topics in Cultural Anthropology. Topics differ by section. Instructor: Staff. 3 units.

203S. African Modernities. 3 units. C-L: see African and African American Studies 213S

207S. Anthropology and History. Recent scholarship that combines anthropology and history, including culture history, ethnography, the study of mentalité, structural history, and cultural biography. The value of the concept of culture to history and the concepts of duration and event for anthropology. Prerequisite: major in history, one of the social sciences, or comparative area studies; or graduate standing. Instructor: Reddy. 3 units. C-L: History 210S

208S. Language Evolution and Acquisition. 3 units. C-L: see Linguistics 203S; also C-L: English 203S

236S. Experimental Communities. 3 units. C-L: see Visual Arts 236S; also C-L: Sociology 236S

249S. Anthropology and Psychology (C, P). Cross-cultural approaches to the psyche, including applications of social psychology, psychoanalysis, and trans-cultural psychiatry to anthropological questions such as culturally expressed psychotic conflicts and pathologies, gender and sexuality, communication, rationality, affect, and motivations. Instructor: Staff. 3 units. C-L: Psychology 249S

262S. Culture, Power, History. Debates in cultural theory and anthropology: identity and nationalism, memory and tradition, globalization, and poststructuralist, feminist and postcolonial theory. Some previous coursework in anthropology and cultural theory recommended. Instructor: Starn. 3 units.

264S. Millennial Capitalisms: Global Perspectives. Critical examination of the problematic of capital from the late nineteenth century until the present moment. Anthropological frameworks and related disciplinary approaches to the multiple cultural productions and lived experiences under divergent forms of capitalism in the new millennium. Focus on East Asia. Theories of capitalism, globalization and anti-globalization movements, "imaginaries" and fantasies, nature and the virtual, consumption, and disciplinary practices of the body. Instructors: Allison and Litzinger. 3 units. C-L: International Comparative Studies 221BS

279S. Race, Racism, and Democracy. The paradox of racial inequality in societies that articulate principles of equality, democratic freedom, and justice for all. Instructor: Allison and Litzinger. 3 units. C-L: History 210S

280. Selected Topics. Special topics in methodology, theory, or area. Instructor: Staff. 3 units.

280S. Seminar in Selected Topics. Same as Cultural Anthropology 280 except instruction provided in seminar format. Instructor: Staff. 3 units.

281S. Masculinities. How masculinities are constructed, performed and inhabited. Theorization of the masculine subject in sociocultural, political and psychodynamic terms within colonial and modernizing contexts. Issues of gendered citizenship. Role of scholarship and the media in constituting hegemonic, subaltern, ethnic, female, and stigmatized masculinities. Instructor: Ewing. 3 units. C-L: Women's Studies 281S

284S. Transnationalism and Public Culture. Critical examination of issues in transnational studies in anthropology and beyond. Tracking the theories of contemporary scholars of the global, and examining new multisited strategies of method, we
explore the emerging ethnographic landscape of the global and the role transnational studies is playing in a revitalized anthropology of the twenty-first century. Instructor: Piot. 3 units.

286S. Development, Modernity, and Social Movements. Modernization and ideologies of progress and nationalism; social movements, revolution, and political protest in the United States and around the world. Some prior background in cultural anthropology or social theory preferred. Consent of instructor required for undergraduate students. Instructor: Silverblatt. 3 units.

287S. Ethnohistory of Latin America. Analysis of what can be known about nonwestern cultures described in texts written by European colonizers. Focus on native peoples whose lives were transformed by Spanish colonialism, with particular attention to post-Inca Andean Societies. Instructor: Silverblatt. 3 units. C-L: History 287BS, Literature 287BS

For Graduate Students Only

300S. Popular Culture, Theories and Practices. Theories and writings about popular culture questioning what it is, its relation to mass and dominant culture(s), what politics and pleasures it carries, and how it varies over time and across space. Project-based with emphasis on conducting studies of popular culture. Focus on methodology analyzing specific forms of popular culture. Issues include transnationalism, capitalism, postmodernism, production, consumption, ethnography, fantasy, and identity. Instructor: Allison. 3 units.

301S. Foucault and Anthropology. A close examination of the work of Foucault and the impact of his work on cultural anthropology. Traces shifts in Foucault’s thinking over the course of his career, examines his work in the context of other major French thinkers, and considers selected works in anthropology that have been particularly influenced by his theories. Instructor: Ewing. 3 units.

302S. Nationalism. Focuses on anthropological approaches to the nation-state, nationalist movements, and state formation. Examines the dynamic relationships between nations and states, colonial and post-colonial policies, and anti-colonial strategies within a changing global context. Addresses the ways belonging and participation are defined within particular states, as well as how these definitions are socialized through a variety of institutional contexts. Finally, explores the relationships between popular culture and state formation, examining these as dialectical struggles for hegemony. Instructor: Staff. 3 units.

303S. Postcolonialism and Its Cultures. An introduction to colonial and postcolonial cultures, forms of knowledge, and theoretical traditions. Explore the foundational scholarship on colonialism within the Indian, European, and U.S. academies; investigate the central debates and arguments in the field of postcolonial theory; and consider postcolonial theory’s relationship to the theoretical traditions of poststructuralism and psychoanalysis. Examine historical and the tropological relationship between colonialism and globalization. Develop a set of critical theoretical tools with which to approach the study of colonial and postcolonial cultures, institutions, discourses, and communities. This course pays particular attention to questions of subjectivity and subject formation, notions of resistance and struggle, and the ways in which colonial power has articulated with race, gender, and sexuality at particular historical moments. Readings in the works of Asad, Fanon, Derrida, Said, Spivak, Stoller and others. Instructor: Stein. 3 units.

304S. Anthropology and the Religious Imagination. An examination of religious movements through the political, racial, gendered, and globalized contours of the contemporary moment. Among other cases to be explored: Jerry Falwell and the religious right, neo-Pentecostalism in the global south, African derived religions in the Americas, Black Hebrew Israelites, transnational Islamic movements, the occult economies of the neoliberal moment, and popular imaginaries of conspiracy. Instructor: Piot. 3 units.

305S. Anthropology and History. 3 units. C-L: see History 305S

306S. Space, Place and Power. Graduate seminar studies foundation and contemporary scholarship on space and place. Trace and compare the ways space is conceptualized and articulated differently in varied disciplinary locations, and aim to establish a conversation between disciplinary literatures and methodologies that are infrequently considered in tandem. Course themes include: the production of space; Marxist and feminist geographies; urban anthropology; home and intimacy; the public sphere; landscape and the production of nature; the politics of cartography; and global cities. Instructor: Stein. 3 units. C-L: Women's Studies 306S, Literature 305S

307S. The Anthropology of the Facts of Life. Course will explore in detail our understandings of “facts” and “life.” Using classic anthropology as well as work in critical science and technology, political philosophy, feminism, and radiology, course will examine relation between nature and culture, how individuals reproduce a society, kinship, and human development. Instructor: Nelson. 3 units.

308S. Citizenship. In this course, we approach modern citizenship as a form of political belonging that is lived collectively and culturally. Second, we will understand citizenship, not through the legal/constitutional ideal of formal equality but as one modality for the elaboration of social inequality. Finally, we will seek to “provincialize” the framework of national citizenship by looking to the elaboration of political belonging and rights in transnational circuits of cultural and political exchange. Instructor: Subramanian. 3 units.

309S. Africa in a Global Age. James Ferguson tells us that Africa’s participation in globalization has certainly not been a matter simply of “joining the world economy.” Rather, Africa’s inclusion has been selective, uneven, and partial. This is quite different than arguing, as many social theorists, economists, and journalists have suggested that the Continent is somehow structurally irrelevant to the process of globalization. This course responds to this debate by first retracing the history of
"globalization," and concludes by thinking about Africa’s place in relation to a new global order. Instructor: Makhulu. 3 units.

330S. Theories in Cultural Anthropology. A two-semester seminar in which the historical development of the field and its modern currents and debates are examined and discussed. Particular topics to be chosen by the instructors. Instructor: Staff. 3 units.

331S. Theories in Cultural Anthropology. A two-semester seminar in which the historical development of the field and its modern currents and debates are examined and discussed. Particular topics to be chosen by the instructors. Instructor: Staff. 3 units.

332S. Research Methods/Portfolio Seminar. In addition to exploring a range of research methods, students work on their field reading lists and other elements of their portfolios and begin to develop the dissertation proposal. Required course for CA graduate students in the second year. Instructor: Staff. 3 units.

333S. Grant Writing. This course focuses on the development of the dissertation research proposal and the preparation of grant proposals. Required for CA graduate students in the third year. Instructor: Staff. 3 units.


380S. Advanced Selected Topics. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

382S. Studies in Ethnomusicology. 3 units. C-L: see Music 382S


399. Special Readings. Supervision and guidance of selected readings at an advanced level. Instructor: Staff. 3 units.

Developmental Psychology
Professor Whitfield, Director of Graduate Studies (235 Soc/Psych)

A certificate is available in this program.

The facilities in developmental psychology at Duke University and the University of North Carolina at Chapel Hill (UNC) offer a collaborative approach to graduate training in developmental psychology: the UNC-Duke Collaborative Graduate Certificate Program in Developmental Psychology. Graduate students in the doctoral programs in Psychology and Neuroscience at Duke and students in UNC’s Department of Psychology can apply to this program that offers training opportunities in addition to those of their home department. Students in the certificate program attend developmental talks at both universities and have opportunities to take developmental seminars or engage in supplemental research training with the faculty of their non-home university. Among the research emphases of the participating faculty are cognitive development, social development, applied development and developmental psychobiology. Students apply to the program by the beginning of their third year of graduate study.

Requirements:

• Must attend at least three program-affiliated developmental events per semester at the non-home institution, for at least six semesters:
  1) Center for Developmental Science talks
  2) Center for Child and Family Policy talks
  3) Colloquium series at both universities
  4) Developmental research and current topics groups, which meet regularly at both universities
  5) Other program-affiliated events in the future

• Fulfill two of the following:
  1) Complete a minimum of two developmentally relevant psychology for-credit courses, taken at the student’s non-home institution (a relevant home institution course co-taught by non-home institution faculty would count).
  2) At least one of the student’s major committees (e.g., Advisory, Comprehensive Exam or Dissertation committee) must have at least one member who is on the developmental faculty of the non-home institution.
  3) Participation in a research activity with a developmental faculty member from the non-home university. May be fulfilled as deemed appropriate by the faculty member providing the experience (e.g., by enrolling in a formal research practicum course, by collaborating on a research project for no course credit, or by employment as a research assistant).
For more information, visit http://pn.aas.duke.edu/graduate/developmentalcert or contact: Director, UNC-Duke Collaborative Program in Developmental Psychology, Duke University, Box 90086, Durham, NC 27708-0085; telephone: (919) 660-5715.

**Developmental and Stem Cell Biology**

Associate Professor Klingensmith, Director

**This is an admitting program.**

**A certificate is also available in this program.**

The Developmental and Stem Cell Biology (DSCB) Training Program provides broad interdepartmental consortium of students and faculty doing developmental research at the molecular, cellular, genetic, evolutionary, and system levels. Each of the commonly used animal modes is investigated, as well as plant developmental models. The curriculum is designed to provide a strong core of knowledge in developmental biology, while allowing students the flexibility to explore individual interests in particular fields, such as Developmental Genetics, Mechanisms of Development, Stem Cells and Regeneration, or Evolution and Development. In the fall of the first year, DSCB students take the Developmental Biology course. It provides a comprehensive introduction to developmental strategies and mechanisms, and key tools to analyze them. DSCB students are also required to take a full-semester graduate-level course in either Cell Biology or Genetics along with the weekly student-organized informal research seminar series, in which Program students present short talks on their research projects. In the spring of the first and second years, students will be required to take the Developmental and Stem Cell Biology Colloquium. Finally, a key component provided by the Program is a teaching experience.

Students entering the Graduate School through the DSCB Training Program usually declare by the end of the first year a department in which to earn their PhD degree. The student must then fulfill all of the normal graduation requirements of the chosen department to complete their PhD studies. This includes additional course work and the successful passing of a qualifying or preliminary exam. The student then focuses on thesis research leading to a doctoral degree from that department, with a certificate in Developmental and Stem Cell Biology.

**Certificate Requirements:**

Application should be made at the beginning of the student’s third year for this Duke/UNC collaborative certificate.

- Must take three program-affiliated developmental events per semester at the non-home institution for at least six semesters.
- Plus two of the following three:
  1) A minimum of two developmentally relevant psychology courses must be taken for credit at the student's non-home institution (a relevant home institution course that is co-taught by a faculty member from the non-home institution would count toward this requirement).
  2) At least one of the student’s major committees (e.g., advisory committee, comprehensive exam committee, dissertation committee) must have at least one member who is on the developmental faculty of the non-home institution.
  3) Participation in a research activity with a developmental faculty member from the non-home university. This may be fulfilled in various ways as deemed appropriate by the faculty member providing the experience (e.g., enrolling in a formal research practicum course, by collaborating on a research project for no course credit, or by employment as a research assistant).

For more information visit http://www.devbio.duke.edu/ or contact: Developmental and Stem Cell Biology, Box 103855, Duke University Medical Center, Durham, MC 27710; telephone (919) 684-6629 or e-mail: devbio@biochem.duke.edu.

**Earth and Ocean Sciences**

Professor Lozier, Chair (333G Old Chemistry); Professor Boudreau, Director of Graduate Studies (306 Old Chemistry); Professors Baker, Boudreau, Chameides, Corliss, Haff, Jackson, Klein, Lozier, Pratson, Vengosh; Associate Professor Murray; Assistant Professors Cassar, Li; Adjunct Faculty Erickson, Hegerl, Isaksen, Johnson, Malin, Molnia, Stanislaw, Young; Professors Emeriti Barber, Heron, Perkins, Pilkey, and Schlesinger

The faculty at EOS conducts research worldwide, from the deep seafloor (5000 meter depth) in the Pacific Ocean to altitudes of 4000 meters in the South American Altiplano. Research interests of the EOS faculty are focused in these main areas: Ocean and Climate Processes, Energy and Water Resources, Earth Surface Processes, and Igneous Petrology and Geochemistry.

Laboratory facilities available in the department are described in this bulletin under the chapter “Resources for Study.”
Degree Requirements

Students entering the graduate program normally have an undergraduate degree in geology or one of the other natural sciences. It is expected that the incoming student will have taken one year of college chemistry, one year of college physics, and mathematics through calculus. Both MS and PhD graduate students take 30 credit hours of courses and research. Typically, the total time for a PhD degree is five years beyond the BS or three years beyond the MS. Because the division encourages participation in fieldwork and other research opportunities outside the university, there are no firm time limits for degrees, except as required by the university.

MS on the way to PhD Degree Option

A student in the PhD program may elect to get a MS degree while working towards the PhD degree. If this option is elected, the requirements are the same as for the MS program in terms of course work, time limits, and thesis requirements.

The student must indicate their intention to receive the MS degree before the deadline in the semester during which they wish to receive the degree. If agreeable to both the student and their committee, the MS defense can be part of the PhD preliminary exam. If this is the case, both a MS Defense and a Preliminary Exam Report must be submitted to the Graduate School. The MS thesis can be on the same topic as the PhD dissertation or different. If the former, the MS thesis must be a fully independent piece of work, which can be referenced but not duplicated in the PhD dissertation.

Up-to-date information about the division and the faculty can be found on our Web site: http://www.nicholas.duke.edu/eos/. For further information on the graduate program, send e-mail inquiries to dgs@eos.duke.edu.

Earth and Ocean Sciences Courses (EOS)

202. Beach and Island Geological Processes. Field seminar on the evolution of beaches and barrier islands with emphasis on the interactions between nearshore processes and human development. Prerequisite: Earth and Ocean Sciences 115/215 or consent of instructor. Also taught as EOS 116. Instructor: Murray. 2 units.


209S. Paleoclimate. Nature and mechanisms of climate variability throughout Earth history. Topics include general theory of climate, paleoclimate modeling and comparisons with observations, methodologies of reconstructing past climate variations, the observational record of paleoclimate extending from the Precambrian through the Ice Ages and Holocene to present, and the impact paleoclimate on biotic evolution/paleogeography and human cultural history. Consent of instructor required. Instructor: Baker. 3 units.

210S. Paleoenvironmental Analysis. Methods of paleoenvironmental and paleoclimatic analysis. Includes radiometric and other methods of dating, stable isotopes, trace elements, paleobiotic and other methods of reconstructing climate, hydrology and environment of the past. Also includes approaches to modeling paleoenvironmental data. Instructor: Baker. 3 units.

211. The Climate System. Components of the climate system: observed climate change, concept of energy balance, basic circulation of the atmosphere and ocean, introduction to climate models, sample applications of climate models, interactions between the atmosphere/ocean/ and biosphere, land surface, cryosphere (snow and ice), and chemistry of the atmosphere. Prerequisite: consent of instructor. Instructor: Staff. 3 units.

212. Climate Change and Climate Modeling. Course aims to provide knowledge and understanding of physics of climate system and Earth system modeling for scientists, engineers and policy students with physics and mathematics background. Fundamental principles controlling physical and dynamic structure of climate system; discussion of relative roles of natural climate variability and external forces and anthropogenic influences. Explore numerical methods, develop computing skills, and deal with data handing as a means to an end of quantifying climate system behavior. Pre-requisite: EOS 211. Instructor: Li. 3 units.

215. Introduction to Physical Coastal Processes. Nearshore physical processes responsible for the evolution of beaches and barrier islands. Various problems and possible solutions arising from human development of retreating shorelines. Involves a field trip and research paper. 3 units.

220. Introduction to Fluid Dynamics. Conservation equations for mass, momentum and heat, with an emphasis on large temporal and spatial scales; application to the earth, ocean, and environmental sciences. Some background in differential equations highly recommended. Instructor: Lozier. 3 units.

225. Fundamentals of Water Biogeochemistry and Pollution. Course is designed to present students with a comprehensive introduction to the sources and impacts of pollution in marine and freshwater environments. Fundamental concepts and principles of aquatic biogeochemistry will first be introduced: marine and freshwater chemistry, primary production and food webs. Topics to be covered include biological (e.g. pathogens, invasive species), physical (e.g. thermal, plastics), and chemical (e.g. nutrient loading, oil, pesticides, metals) pollutants. Instructor: Cassar. 3 units.

226S. Water Forum Speaker Series. Seminar including visiting scholars covering a broad array of issues on water including water quality, hydrogeology, biogeochemistry, water management, water treatment, ecology, water economy, and water
policy and law at both the national and international levels. Instructor: Vengosh. 3 units.

227. International Water Resources. Overview of the hydrology, hydrogeology, water quality, and management of major international water resources. Focus on cross-boundary international rivers and aquifers, up-stream versus down-stream water users, the politics of water sharing and disputes, the role of science in water management, and prospects and implications for future utilization of contaminated rivers and stressed aquifers. Examples from international rivers such as the Tigris, Euphrates, Nile, Jordan, Colorado, Indus, Ganges, and Mekong and international aquifer systems such as the Mountain aquifer, Gaza Strip, Disi, and Nubian basins in northern Africa. Instructor: Vengosh. 3 units.


242S. New Perspectives and Methods in Surface Process Studies. Nonlinear dynamics and related approaches to understanding, modeling, and analyzing physical systems, with emphasis on applications in geomorphology. Consent of instructor required. Instructor: Murray. 3 units.

243S. Landscape Dynamics. How landscape changes with time. The dynamics and mechanisms of earth surface processes underlying landscape change. Hillslope, fluvial, marine, glacial, volcanic, tectonic and aeolian processes. Reading and discussion of primary literature; several field trips to Duke Forest. Prerequisite: Earth and Ocean Sciences 11 or consent of instructor. Instructor: Haff and Pratson. 3 units.

244. Geoengineering. Discussion of proposals for large-scale intentional modification and/or control of climate. Physical mechanisms, intended benefits, risks, costs, scenarios for deployment, historical analogs, possible unintended physical and social consequences, ethical dilemmas, oath for earth and environmental scientists. Prerequisite: one course in Earth and Ocean Sciences or consent of instructor. Instructor: Haff. 3 units.

245S. The Neoenvironment. Introduction to the emerging world of the 21st century, "the neoenvironment," where life, environment, and social interaction are increasingly engineered by novel technologies. Topics include transition of science from observation and understanding to manipulation and control, acceleration of technology, emergence of the internet and other global networks, novel life forms, redesigning of humans, artificial intelligence, virtual worlds, proliferation of computation and surveillance in the environment, numericalization of nature and society. Prerequisite: one course in Earth and Ocean Sciences or consent of instructor. Instructor: Haff. 3 units.

251S. Global Environmental Change. Topics in the seminar will include climate change, earth surface alteration, prediction, water and carbon cycling, sea-level rise and coastal erosion, biodiversity, fossil fuels and energy resources, water resources, soil fertility, human impact on coastal zone ecosystems. Prerequisite: consent of instructor. Instructor: Murray. 3 units.

267. Analyzing Time and Space Series. Ways to extract information from data; methods for probing time or spatial series including spectral and wavelet analyses, correlation techniques, and nonlinear-dynamics approaches for determining how deterministic and linear the processes producing the data are, and for reconstructing and quantitatively comparing state-space plots. Instructor: Murray. 3 units.

269. Thermodynamics of Geological Systems. Introductory thermodynamics applied to geologic problems through understanding of phase equilibrium. Prerequisites: Earth and Ocean Sciences 101L; and Mathematics 32 or consent of instructor. Instructor: Boudreau. 3 units.

271. Stable and Radioactive Isotopes in Environmental Sciences. Theory and applications of stable and radioactive isotope distributions in nature (including oceanographic, geologic, hydrologic, and biological processes). Prerequisites: Chemistry 32L and Mathematics 32. Instructor: Vengosh. 3 units.

273S. Analytic Techniques. An introduction to advanced analytic procedures used in the earth sciences: such as electron microbeam techniques (scanning electron microscopy, electron microprobe analysis) and plasma emission/absorption spectroscopy. Consent of instructor required. Instructor: Boudreau. 3 units.

275S. Mineral Resources. Introduction to the mineralogy, geological setting, and genesis of metallic and non-metallic deposits (gold, copper, iron, aluminum, gypsum, phosphates, diamonds, e.g.). Includes methods of mineral exploration and exploitation, and the environmental consequences of utilizing mineral resources. An introductory geology course background useful but not required. Instructor: Boudreau. 3 units.


291. Independent Study. Consent of instructor required. Instructor: Staff. 3 units.

293S. Frontiers of Geology I. Survey of the history, status, and trajectory of "hard-rock" petrology, structural geology, tectonics, and geophysics. Instructors: Karson and staff. 3 units.

294S. Frontiers of Geology II. Survey of the history, status, and trajectory of "soft-rock" petrology, stratigraphy, sedimentation, geochemistry, hydrology, and paleontology. Instructors: Karson and staff. 3 units.
The Asian/Pacific Studies Institute (APSI) at Duke University administers an innovative and interdisciplinary Master’s Program in East Asian Studies. The program offers broad choices and can be individually tailored to suit each student’s goals. It meets the needs of students planning to enter professional careers such as the diplomatic corps, international law, education, and business as well as providing academic enhancement for mid-career professionals in these fields. It is also designed to prepare students who wish to continue on to doctoral programs. The temporal focus of the program is on the nineteenth and twentieth centuries, with fields of specialization available in Art and Art History, Cultural Anthropology, History, Modern Literature, Political Science, Psychology, Religion, and Sociology. Thematic foci past students in the program have explored include cultural and literary studies, development and policy studies, gender, sexuality and ethnicity, institutional transformation, and politics and society. The program encourages the crossing of traditional disciplinary boundaries through interdisciplinary study.

Degree Requirements

The master's degree in East Asian Studies requires ten courses (30 credits), including an integrated required core course, of which at least eight (24 credits) must be in East Asian Studies. These must be drawn from a list of approved courses, with no more than four (12 credits) taken in any one department. Fourth-year college-level East Asian language courses may be counted toward the eight-course requirement. Also, eight of the ten courses (24 credits) must be at the graduate level.

In lieu of a thesis, the Program requires the completion of a capstone course and a research paper or an annotated bibliography in the area or topic of specialization. The degree is dependent on the acceptance of the research paper or annotated bibliography by the Graduate Committee and successful completion of an oral examination on the project by the Program’s advisory committee of three faculty members, two of whom must be APSI core faculty members. Students are directed in their course of study by the APSI Director of Graduate Studies, along with an individual faculty advisor. The capstone course is to be chosen with the help of the advisor, who must be a member of the APSI core faculty. At the conclusion of the Program, students must have attained advanced proficiency in one East Asian language, equivalent to three years of college-level study. It is strongly recommended that applicants complete at least one year of such language study before beginning the program at Duke. Students who are native speakers of an East Asian language are encouraged to take one year (two semesters) of another East Asian language.

Joint JD/MA Degree

The Asian/Pacific Studies Institute also administers a joint JD/MA degree. Admission to this program is contingent upon admission to the Duke Law School. Degree requirements for the MA portion are eight graduate courses focusing on East Asia (must be graded). Students also need to register for six units of research, which can be ungraded. While some law courses pertaining to East Asia can be counted as graduate courses, students must register them as Graduate School courses, rather than Law School courses.

Joint JD/MA Program

The Asian/Pacific Studies Institute also administers a joint JD/MA degree. Admission to this program is contingent upon admission to the Duke Law School. Degree requirements for the MA portion are eight graduate courses focusing on East Asia (must be graded), and the completion of the capstone project. Students also need to register for six units of research, which can be ungraded. While some Law courses pertaining to East Asia can be counted as graduate courses, students must register them as Graduate School courses, rather than Law School courses.

CERTIFICATE in EAST ASIAN STUDIES

Students affiliated with any of the Graduate School’s programs who are not pursuing the interdisciplinary Master’s Degree in East Asian Studies, are encouraged to document their specialization in the region by earning a Certificate in East Asian Studies in conjunction with their master’s or doctoral degree. Students must formally apply for the Certificate and must complete at least four courses from an approved list of courses in East Asian Studies, from at least two different departments or programs, together with minimum language proficiency (two years) in an East Asian language (Chinese, Japanese, or Korean). An Asian/Pacific Studies Institute faculty advisor will be assigned to each applicant for the Certificate.
The Certificate is signed by the Director of Graduate Studies for East Asian Studies and the Dean of the Graduate School. Appropriate notation is made on the student’s transcript.

Certificate Requirements:
• Complete at least four courses from an approved list of EAS courses, in at least two different departments or programs.
• Have a two-year minimum language proficiency in an East Asian language (Chinese, Japanese, or Korean).
• An Asian/Pacific Studies Institute faculty advisor will be assigned to each certificate applicant.

For more information, visit http://web.duke.edu/apsi/programs/eacert.html.

COURSES IN EAST ASIAN STUDIES OFFERED BY DEPARTMENTS AND PROFESSIONAL SCHOOLS

Art History (ARTHIST)

Asian & Middle Eastern Studies (AMES)
138. Traffic in Women: Cultural Perspectives on Prostitution in Modern China.
148. Critical Inter-Asia: Rethinking Local and Global Connections.
169. China and the West.
175. World of Korean Cinema.
176. Gender in Dance and Theatre.
179. Melodrama East and West.
184. Music in East Asia.
250S. Chinese Media and Pop Culture.
253. East Asian Cultural Studies.
279. Melodrama East and West.

Chinese (CHINESE)
1. Elementary Chinese.
35. Literacy in Chinese.
38. Intensive Literacy in Chinese.
63. Intermediate Chinese.
125. Advanced Chinese.
135. Readings in Modern Chinese.
136. Reading in Modern Chinese.
181S. Language and Society.
183S. Topics in Modern Chinese.
191. Research Independent Study.
195. Contemporary Chinese Culture.

Cultural Anthropology (CULANTH)
142A. Traffic in Women: Cultural Perspectives on Prostitution in Modern China.
149A. Gender in Dance and Theatre.
161A. World of Korean Cinema.
191N. Sex and Money.
254. East Asian Cultural Studies.

Dance (DANCE)
114. T'ai Chi and Chinese Thought.
175. Gender in Dance and Theatre.

Economics (ECON)
267S. Global Responses to the Rise of China.

English (ENGLISH)

Film/Video/Digital (FVD)
111G. World of Korean Cinema.

History (HISTORY)
143A. Ancient and Early Modern Japan.
172B. China and the West.
233AS. Narrative, History, and Historical Fiction.

Information Science and Information Studies (ISIS)
225S. Chinese Media and Pop Culture.

Interdisciplinary (INTERDIS)
<table>
<thead>
<tr>
<th>Code</th>
<th>Course Description</th>
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<tbody>
<tr>
<td>160B</td>
<td>Medical Chinese.</td>
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<tr>
<td></td>
<td><strong>International Comparative Studies (ICS)</strong></td>
</tr>
<tr>
<td>90A</td>
<td>Religions of Asia.</td>
</tr>
<tr>
<td>120A</td>
<td>Taoism and Chinese Religion.</td>
</tr>
<tr>
<td>120F</td>
<td>Reading in Modern Chinese.</td>
</tr>
<tr>
<td>120G</td>
<td>Chinese Buddhist Art.</td>
</tr>
<tr>
<td>122A</td>
<td>Critical Inter-Asia: Rethinking Local and Global Connections.</td>
</tr>
<tr>
<td>122C</td>
<td>Traffic in Women: Cultural Perspectives on Prostitution in Modern China.</td>
</tr>
<tr>
<td>122E</td>
<td>Vampire Chronicles: Fantasies of Vampirism in a Cross-cultural Perspective.</td>
</tr>
<tr>
<td>170A</td>
<td>Melodrama East and West.</td>
</tr>
<tr>
<td>170E</td>
<td>Gender in Dance and Theatre.</td>
</tr>
<tr>
<td>201AS</td>
<td>Political Participation: Comparative Perspectives.</td>
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<tr>
<td></td>
<td><strong>Japanese (JPN)</strong></td>
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<tr>
<td>1</td>
<td>Elementary Japanese.</td>
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<tr>
<td>63</td>
<td>Intermediate Japanese.</td>
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<tr>
<td>125</td>
<td>Advanced Japanese.</td>
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<tr>
<td>183S</td>
<td>Topics in Japanese.</td>
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<tr>
<td>191</td>
<td>Research Independent Study.</td>
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<tr>
<td></td>
<td><strong>Korean (KOREAN)</strong></td>
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<tr>
<td>1</td>
<td>Elementary Korean.</td>
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<tr>
<td>63</td>
<td>Intermediate Korean.</td>
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<tr>
<td>125</td>
<td>Advanced Korean.</td>
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<tr>
<td>184S</td>
<td>Topics in Korean.</td>
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<tr>
<td>191</td>
<td>Research Independent Study.</td>
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<tr>
<td></td>
<td><strong>Literature (LIT)</strong></td>
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<tr>
<td>112G</td>
<td>World of Korean Cinema.</td>
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<tr>
<td>151J</td>
<td>Melodrama East and West.</td>
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<tr>
<td>151M</td>
<td>Vampire Chronicles: Fantasies of Vampirism in a Cross-cultural Perspective.</td>
</tr>
<tr>
<td>162G</td>
<td>Traffic in Women: Cultural Perspectives on Prostitution in Modern China.</td>
</tr>
<tr>
<td>165NS</td>
<td>Critical Inter-Asia: Rethinking Local and Global Connections.</td>
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<tr>
<td>254</td>
<td>East Asian Cultural Studies.</td>
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<tr>
<td></td>
<td><strong>Music (MUSIC)</strong></td>
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<tr>
<td>134</td>
<td>Music in East Asia.</td>
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<td></td>
<td><strong>Philosophy (PHIL)</strong></td>
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<td>163</td>
<td>Chinese Philosophy.</td>
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<tr>
<td>291S</td>
<td>Special Fields of Philosophy.</td>
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<td></td>
<td><strong>Political Science (POLSCI)</strong></td>
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<td>206S</td>
<td>Political Participation: Comparative Perspectives (B).</td>
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<td></td>
<td><strong>Religion (RELIGION)</strong></td>
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<tr>
<td>44</td>
<td>Buddhism.</td>
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<td>45</td>
<td>Religions of Asia.</td>
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<tr>
<td>107A</td>
<td>Taoism and Chinese Religion.</td>
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<td>114</td>
<td>Tai Chi and Chinese Thought.</td>
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<tr>
<td>161E</td>
<td>Music in East Asia.</td>
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<td></td>
<td><strong>Sociology (SOCIO)</strong></td>
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<tr>
<td>144</td>
<td>Technology and Organizational Environments.</td>
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<tr>
<td>145</td>
<td>Nations, Regions, and the Global Economy.</td>
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<tr>
<td>222S</td>
<td>Proseminar in Comparative and Historical Sociology.</td>
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<tr>
<td>290S</td>
<td>Global Responses to the Rise of China.</td>
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<tr>
<td></td>
<td><strong>Study of Sexualities (SXL)</strong></td>
</tr>
<tr>
<td>131S</td>
<td>Vampire Chronicles: Fantasies of Vampirism in a Cross-cultural Perspective.</td>
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<tr>
<td>138</td>
<td>Traffic in Women: Cultural Perspectives on Prostitution in Modern China.</td>
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<tr>
<td></td>
<td><strong>Theater Studies (THEATRST)</strong></td>
</tr>
<tr>
<td>132</td>
<td>Gender in Dance and Theatre.</td>
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<tr>
<td>132A</td>
<td>Asian American Theatre.</td>
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<tr>
<td></td>
<td><strong>Visual Studies (VISUALST)</strong></td>
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<tr>
<td>105E</td>
<td>Melodrama East and West.</td>
</tr>
<tr>
<td>105F</td>
<td>World of Korean Cinema.</td>
</tr>
<tr>
<td></td>
<td><strong>Women's Studies (WOMENST)</strong></td>
</tr>
<tr>
<td>111</td>
<td>Gender in Dance and Theatre.</td>
</tr>
<tr>
<td>131S</td>
<td>Vampire Chronicles: Fantasies of Vampirism in a Cross-cultural Perspective.</td>
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<tr>
<td>179</td>
<td>Melodrama East and West.</td>
</tr>
</tbody>
</table>
Ecology

Professor Morris, Chair; Professor Richter (environment), Director of Graduate Studies; Professors Alberts (biology), Baker (environment), Christensen (environment), Clark (biology), Crowder (environment), Glander (evolutionary anthropology), Jackson (biology), Katul (environment), Mitchell-Olds (biology), Nowicki (biology), Oren (environment), Pimm (environment), Rausher (biology), Reynolds (environment), Richardson (environment), Willis (biology), Yoder (biology); Associate Professors Drea (evolutionary anthropology), Porporato (civil and environmental engineering), Reed (environment), Rittschof (environment), Urban (environment), and Wilson (biology); Assistant Professor Bernhardt (biology), Koelle (biology), Leal (biology), and Wright (biology); Associate Professors of the Practice Halpin (environment) and Kirby-Smith (environment)

A PhD and a certificate are available in this program. (The Certificate in Ecology with PhD is available through one of the participating departments—Evolutionary Anthropology, Biology, Environment, Civil and Environmental Engineering, or Statistical Science).

The University Program in Ecology (UPE) provides interdisciplinary training in all aspects of ecology, including physiological and behavioral ecology; population and evolutionary ecology; community and landscape ecology; biogeochemistry; and ecosystem and global change ecology. The program serves to integrate an exceptionally broad and diverse collection of faculty expertise found in various departments and schools at Duke. The UPE is a rigorous, research-oriented graduate program with an excellent record of scholarly publications by our students. All students participate in a two-semester, graduate-level core course that focuses on both historical and contemporary foundations of ecology (theory, principles, and research); any additional coursework is tailored to each student’s specific interests and needs. Students organize and run a weekly seminar series and informally participate in various readings groups.


Certificate Requirements:

• Complete two semesters of CORE historical and contemporary foundations of ecology courses.

• Organize and run weekly seminar sessions.

For more information, visit http://www.ecology.duke.edu/.

University Program in Ecology Courses (UPE)
301. Population, Community, and Behavioral Ecology. 4 units.
302. Physiological Ecology and Ecosystem Analysis. 4 units.
309. Ecological Forecasting Workshop. 3 units. C-L: Biology 309

Economics

Professor Bayer, Chair (213 Social Sciences); Professor Rossi, Director of Graduate Studies (204 Social Sciences); Research Professor Becker, Director of Master’s Program and Co-Chair (312 Social Sciences); Associate Professor Khan, Director of Graduate Admissions (221B Social Sciences). Primary Appointments: Professors Abdulkadiroglu, Arcidiacono, Bayer, Bollerslev, Burnside, De Marchi, Goodwin, Grabowski, Graham, Hoover, Hotz, Kelley, Kimbrough, Kranton, Kuran, Lewis, McElroy, Nechyba, Rubio-Ramirez, Sanders, Sloan, Tauchen, Taylor, Thomas, Tower, Weintraub; Associate Professors Khan, Mazzocco, Peretto, Rossi, Timmins, Yildirim; Assistant Professors Beresteau, Bugni, Leventoglu, Roberts, Sadowski, Sweeting, Tarozzi; Professors Emeriti Blackburn, Kreps, Naylor, Treml, Vernon, Wallace; Secondary Appointments: Professors Anton, Ariely, Bansal, Clintfelter, Cohen, Coleman, Darby, Gallant, Hsieh, Kramer, Ladd, Marx, Munger; Associate Professors Conrad, Hamilton, McAdams, Pfaff, Smith, Vigdor; Assistant Professors Ananat, Bellemare, Conitzer, Khwaja, Lopomo, Ridley, Rigotti

The Department of Economics offers graduate programs leading to the AM and PhD degrees.

Students preparing to enter these programs will find an undergraduate background in mathematics, statistics, and economics to be very helpful. Requirements for the PhD degree in economics include obtaining high grades in the first year classes of microeconomics, macroeconomics, and econometrics. Advanced study is offered in economic theory, macroeconomics, applied microeconomics (including industrial organization, labor economics, public economics, and development economics), history of political economics, and certain fields outside the economics department such as finance. The standard time to completion of the PhD is five years.

For additional information, please visit our Web site at: http://www.econ.duke.edu/.

Economics Courses (ECON)
205. Microeconomics. Topics include theory of consumer choice, demand, uncertainty, competitive and imperfectly
206. Advanced Microeconomic Analysis. Topics include consumption, production, investment, uncertainty and information. Not open to students who have taken this course as Economics 201. Instructor: Becker or Graham. 3 units.

207. Models of Conflict and Cooperation. Cooperative and noncooperative game theory with applications to trading, imperfect competition, cost allocation, and voting. Prerequisite: Economics 105D. Instructor: Graham. 3 units.

207S. Models of Conflict and Cooperation. Cooperative and non-cooperative game theory with applications to trading, imperfect competition, cost allocation, and voting. Extensive use of quantitative models requiring familiarity with multivariate calculus, optimization, and probability theory. Prerequisite: Economics 105D. Instructor: Graham. 3 units.

208S. Economics of the Family. Economic functions of families including home production gains from marriage, the demand for children, marriage and divorce, child support and alimony, labor supplies of women and men, the distribution of resources within families ('rotten kid theorems' and cooperative and noncooperative games). Applications to marriage and divorce law, day care, United States welfare policy, mortality, and farm efficiency in developing nations. Research project required. Prerequisite: Economics 105D; Economics 139D; and Statistics 101, 103, 104, 112, 113 or 114, or Mathematics 135 or 136. Instructor: McElroy. 3 units. C-L: Women's Studies 208S

210. Macroeconomic Theory. Micro-founded dynamic general equilibrium models have become the standard tool for macroeconomic analysis. Course provides guidance on how to work with these models. Our baseline New Keynesian model will feature sticky prices combined with monopolistic competition. We will show that the result in framework is appealing from an empirical point of view and we will use it to assess the desirability of alternative arrangements for the conduct of monetary policy. Prerequisite: Economics 205. Instructor: Staff. 3 units.

214S. Economy, Society, and Morality in Eighteenth-Century Thought (C-N), 3 units. C-L: see Political Science 214S

218. Macroeconomic Policy and International Finance. 3 units. C-L: Public Policy Studies 218

220. Time Series Econometrics. Empirical research in macroeconomics and international finance, providing students with a series of econometric tools for empirical analysis of time-series and an introduction to the current empirical research in macroeconomics, international finance, and forecasting. Small project and simple empirical research required. Prerequisites: Satisfactory performance (as judged by the instructor) in Econometrics (Economics 139D) plus a course in Linear Algebra or consent of the instructor. A course in macroeconomics (Economics 110D) is very useful but not strictly enforced. Instructor: Rossi. 3 units.

225. Mathematical Finance. 3 units. C-L: see Mathematics 215

230S. Economics of Creative Good. Creative industries (especially the arts, entertainment) often distinguished by peculiarities of product (for example, non-durable), by special nature of financing and contracting (for example, option contracts), and by challenges they present to conventional analysis of pricing and consumption. Research report required. (Taught only in the Duke-in-Venice Program.) Similar to Economics 130S but intended for M.A. students. Instructor: De Marchi. 3 units.

231S. Law, Economics, and Organizations. 3 units. C-L: see Public Policy Studies 231S

232S. Microeconomics of International Development Policy. 3 units. C-L: see Public Policy Studies 232S

233. Economic History and Modernization of the Islamic Middle East. Economic development of the Middle East from the rise of Islam to the present. Transformation of the region from an economically advanced area into part of the underdeveloped world. Role of religion in economic successes and failures. Obstacles to development today. Topics: Islamic economic institution, economic roles of Islamic law, innovation and change, political economy of modernization, interactions with other regions, economic consequences of Islamism. Consent of instructor required. Instructor: Kuran. 3 units.

239D. Introduction to Econometrics. Data collection, estimation, and hypothesis testing. Use of econometric models for analysis and policy. (Same as Economics 139D but requires additional term paper; not open to students who have taken Economics 139D.) For Economics majors only. Prerequisite: Economics 2, 2D, 52D or 55D; Mathematics 103 (co-requisite); Statistics 101, 103, 104, 112, 113 or 114 or Mathematics 135 or 136. Instructor: Tarozzi or staff. 3 units.

241. Applied Econometrics in Macroeconomics. Basic econometric methods useful in empirical economic research and forecasting. Topics include multiple regression analysis under nonstandard conditions; probit, logit, and other limited dependent variables; count data; simultaneous equation systems; and models with panel data. Focus on macroeconomic applications. (Same as economics 141, but requires additional paper; not open to students who have taken Economics 141.) Prerequisite: Economics 139D or 239D. Instructor: Rossi. 3 units.

242. Applied Econometrics in Microeconomics. Empirical research in microeconomics, with emphasis on three main subfields: labor economics, public economics, and industrial organization. Focus on current empirical research in these areas and student independent analysis of current research using statistical software. Same as Econ 142, but additional work required. Not open to students who have taken Economics 141B, 142 or 241B. Prerequisite: Economics 139D or 239D. Instructor: Staff. 3 units.

244S. Art and Markets. 3 units. C-L: see Visual Studies 252AS; also C-L: Medieval and Renaissance Studies 245S

246. Adam Smith and the System of Natural Liberty. Same as Economics 146, but requires an additional paper; not open to students who have taken Economics 146 or 151. Instructor: De Marchi. 3 units.

247S. Political Economy of Growth, Inflation, and Distribution (A,B). 3 units. C-L: see Political Science 246S

248. History of Economic Thought. Approaches to economic problems from Aristotle to Keynes, emphasizing certain models and doctrines their origins, relevance, and evolution. Readings from Mun, Quesnay, Adam Smith, Malthus, Ricardo, Marx, Walras, Veblen, and Keynes. (Similar to Economics 148, but requires an additional assignment. Not open to students who have taken Economics 148.) Prerequisite: Economics 55D. Instructor: Goodwin. 3 units.

251S. Regulation of Vice and Substance Abuse. 3 units. C-L: see Public Policy Studies 251S


253. International Trade and Policy. 3 units. C-L: see Public Policy Studies 204

255. Labor Economics. Demand for and supply of labor, including human fertility, human capital, hours of work, and labor force participation. Effects of family structure, marriage laws, taxes and transfers (welfare, earned income tax credit) on labor supply and the distribution of income across families and individuals. Labor market discrimination, unions, Background in microeconomics and econometrics recommended. Similar to Economics 155, but intended for MA students. Instructor: Arcidiacono, McElroy, or Sloan. 3 units.

257. Financial Markets and Investments. Same as Economics 157, but requires an additional paper. Not open to students who have had Economics 158/258 before Fall 1998. Prerequisite: Economics 105D; Economics 110D; and Statistics 101, 103, 104, 112, 113 or 114, or Mathematics 135 or 136. Instructor: Bollerslev or Tauchen. 3 units.

261. Evaluation of Public Expenditures. 3 units. C-L: see Public Policy Studies 261; also C-L: Environment 272

262S. Seminar in Applied Project Evaluation. 3 units. C-L: see Public Policy Studies 262S

264. The History of Modern Macroeconomics from Keynes to the Present. Examination of key developments in macroeconomics from the 1930s through the present. Case studies of the evolution of macroeconomics in political and social context. Topics include the theory of unemployment in the Great Depression; growth theory and the rise of business cycle modeling in the aftermath of World War II; the trade-off between inflation and unemployment in the 1950s and 1960s; the debate over monetarism in the age of stagflation; and the rise of the New Classical Macroeconomics in its aftermath. Not open to students who have taken Economics 164. Instructor: Hoover. 3 units.

265S. International Trade. International trade, investment and migration, commercial policy, and the political economy of trade. Prerequisite: Economics 105D; and Economics 110D. Instructor: Kimbrough or Tower. 3 units.

266S. International Monetary Economics. Financial aspects of growth and income determination, and macroeconomic policy in open economies. Applications to exchange rate determination, capital markets, fluctuations in the trade balance and current account, monetary and fiscal policies in open economies, currency crises, and monetary reform. Significant research component required. Prerequisite: Economics 55D. Instructor: Kimbrough. 3 units.

267S. International Monetary Economics. Financial aspects of growth and income determination, and macroeconomic policy in open economies. Applications to exchange rate determination, capital markets, fluctuations in the trade balance and current account, monetary and fiscal policies in open economies, currency crises, and monetary reform. Significant research component required. Prerequisite: Economics 55D. Instructor: Kimbrough. 3 units.

268. Asset Pricing & Risk Management. Pricing models for major asset classes including bonds and equities, as well as derivative securities including futures and options on equity indices, currencies and commodities. Portfolio risk analysis speculation and hedging techniques. Instructor: Raisel. 3 units.

269S. Global Responses to the Rise of China. 3 units. C-L: see Sociology 290S

270. Asset Pricing & Risk Management. Pricing models for major asset classes including bonds and equities, as well as derivative securities including futures and options on equity indices, currencies and commodities. Portfolio risk analysis speculation and hedging techniques. Instructor: Raisel. 3 units.

271. Social Change, Markets, and Economy in China. 3 units. C-L: see Sociology 293S
270. Resource and Environmental Economics. 3 units. C-L: see Environment 270; also C-L: Public Policy Studies 272
270D. Resource and Environmental Economics and Policy (DISCUSSION). 3 units. C-L: see Environment 270D; also C-L: Public Policy Studies 272D
270L. Resource and Environmental Economics. 3 units. C-L: see Environment 270L; also C-L: Public Policy Studies 272L
270S. International Macroeconomics. Analysis of the determinants of international capital movements, trade imbalances, nominal and real exchange rates. Policy debates such as the foreign indebtedness of the United States, emerging market debt crises, exchange-rate-based inflation stabilization, and balance-of-payment crises. Same as Econ 170 but with additional work. This course is not open to students who have taken Econ 170. Prerequisites: Economics 105D and 110D. Instructors: Burnside or staff. 3 units.
273. Economic Analysis of Resource and Environmental Policies. 3 units. C-L: see Environment 271
275. Urban Economics II. Historical evolution of cities from an economic perspective, considering the factors driving urban growth and decline at different points in history and the evolving organization of economic activity and social living within cities. Additional topics include dynamics of suburbanization and inner city decline, racial and ethnic segregation; urban industrial structure and spatial distribution of jobs; and impact of metropolitan political structure on urban sprawl and provision of public goods. Prerequisites: Intermediate Microeconomics (Economics 105D) required; Econometrics (Economics 139D) strongly recommended. Instructor: Bayer. 3 units.
276. Mathematical Economics. Topics include a review of differential and integral calculus; overview of matrix algebra, comparative statics, constrained optimization; introduction to differential equations and difference equations. Prerequisite: basic knowledge of differential and integral calculus. Instructor: Rubio-Ramirez or staff. 3 units.
277. Game Theory. An introduction to non-cooperative game theory with emphasis on both games of complete information and games of incomplete information. Application from economics, biology, law, and political science. Offered only in the summer. Prerequisite: Economics 205. Instructor: Taylor. 1.5 units.
278. Mathematical Economics II. Addresses more formal mathematical modeling in economics and provides an introduction to real analysis and mathematical dynamics. Offered only in the summer. Instructor: Staff. 3 units.
279. Advanced Microeconomics II. Formal theory and developing proofs; attention paid to empirical implications of theory. Offered only in the summer. Instructor: Staff. 1.5 units.
283. Advanced Macroeconomics II. Course considers macroeconomic models and computational tools. Will benefit those interested in going to doctoral program, as the course covers underlying tools for PhD macroeconomics. Basic Dynamic Stochastic General Equilibrium macro models reviewed and used to learn numerical and empirical approaches. Course emphasizes real business cycle theory and sticky price models for monetary policy; linearization around steady states; and Bayesian estimation of DSGE models. How modern monetary policy research is implemented in practice. First half of course focuses on numerical analysis; second half devoted to empirical analysis and sticky price models. Instructor: Ochoa. 3 units.
284S. Financial Development and History. Development of financial institutions and markets across civilizations and time. The political, economic, and institutional factors which influenced that evolution and the theoretical implications for contemporary emerging markets. Prerequisite: Economics 151, 181 or consent of instructor. Instructor: Toniolo. 3 units.
285. Economics of Global Health. Application of economic methods to examine key emerging issues in global health, with focus on health disparities. Emphasis on using economic models to better understand global health challenges and using econometric methods to empirically test hypotheses that seek to explain global health disparities. Discuss measurement of health and data quality. Explores individual, family and society-level determinants of health; impact of health on economic and social prosperity; demand and supply of health care. Discuss policy implications in each case. Instructor: Thomas. 3 units.
286. Economic Growth and Development Policy. 3 units. C-L: see Public Policy Studies 286
287. Public Finance. Same as Economics 187, but requires additional graduate-level work; not open to students who have taken Economics 187. Prerequisite: Economics 105D. Instructor: Falba or staff. 3 units.
288. Competitive Strategy and Industrial Organization. Foundations of the field of industrial organization, including the theory of the firm, models of competition, market structure, pricing and dynamic models. Emphasis on theory with support from specific industries, including telecommunications, retail and airlines. Similar to Economics 188, but requires additional assignment. Not open to students who have taken Economics 188. Instructor: Beresteau, Khan, or Yildirim. 3 units.
289. Applied Econometrics II. Time series analysis, non-linear and systems modeling, limited dependent variables, and hazard models. Probability and distribution theory, and statistical inference. Issues of functional form, qualitative form,
290S. The Development of Modern Economic Thought. Selective survey of the development of economic thinking in the twentieth century, with emphasis on the construction of economics as a science. Research papers required. (Similar to Economics 190, but requires an additional assignment. Not open to students who have taken Economics 190). Prerequisite: Economics 55D. Instructor: Weintraub. 3 units.

291. European Economic History. Covers period since the late eighteenth century. Topics include: modern economic growth in historical perspective, the industrial revolution, the standard-of-living debate, patterns of European growth (with case studies of France, Germany, Italy, and Russia), the classical gold standard, the economic consequences of World War II, the great depression, postwar reconstruction, and the European "miracle" of the 1950s and 1960s. Prerequisites: Economics 105D; and Economics 110D. Instructor: Toniolo. 3 units.

293. Research Independent Study. Individual research in a field of special interest under the supervision of a faculty member, the central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Consent of instructor and director of graduate studies or MA program director required. Instructor: Staff. Variable credit.

294. Independent Study. Individual non-research, directed reading, or individual project in a field of special interest under the supervision of a faculty member. Consent of instructor and director of graduate studies or MA program director required. Instructor: Staff. Variable credit.

295. Selected Topics in Economics. Instructor: Staff. 3 units.

295S. Selected Topics in Economics. Seminar version of Economics 295. 3 units.

296. Selected Topics in Economics. Instructor: Staff. 3 units.

296S. Selected Topics in Economics. Seminar version of Economics 296. Instructor: Staff. 3 units.

297S. Economic Science Studies. Application of techniques of science and technology studies to problems in the history, philosophy, methodology and sociology of economics. Addresses modern economics as a illustrative case of issues arising in Studies of Scientific Knowledge. What counts as "fact" in economics? Who decides, and by what processes of negotiation? Does accepting that knowledge in economics as a construct reduce the usefulness of that knowledge and affect the notion of progress in economic science? Why has mathematical economics enjoyed such success in recent decades? Close readings in texts across the sciences and in modern economics, and the history of mathematics, culminating in a research project. (Similar in context to Economics 197S, but requires an additional assignment. Not open to students who have taken Economics 197S or Sociology 187S.) Prerequisites: Economics 105 or 149; and Economics 110 or 154; and consent of instructor. Instructor: Weintraub. 3 units.

For Graduate Students Only

300. Mathematics for Economists. Topics include linear and matrix algebra, topology, multivariate calculus, optimization and dynamic systems. Intended for entering PhD students. Instructor: Graham or Staff. 3 units.

301. Microeconomic Analysis I. Review of contemporary theory relating to consumer choice, production, the firm, and income distribution in competitive and imperfectly competitive markets. Restricted to PhD students in economics except with consent of instructor and director of graduate studies. Instructor: Yildirim. 3 units.

301D. Microeconomic Analysis I. Same in content as Economics 301, but with weekly discussion section. Instructor: Yildirim. 3 units.

302. Microeconomic Analysis II. A continuation of Economics 301 with emphasis on analyses of consumer behavior, general equilibrium, welfare economics, and capital theory. Prerequisite: Economics 301. Instructor: Taylor. 3 units.

302D. Microeconomic Analysis II. Same in content as Economics 302, but with weekly discussion section. Instructor: Taylor. 3 units.

304. Advanced Macroeconomics. Advanced topics in macroeconomics with some emphasis on computation and econometric analysis. Topics include real business cycle theory, endogenous growth theory, monetary theory, optimal monetary and fiscal policy and time consistency. Instructor: Peretto. 3 units.

305. Monetary Theory and Policy. Same topics as Economics 205S but with additional graduate level work. Prerequisite: Economics 304. Instructor: Staff. 3 units.

306. Microeconomics: Policy Applications. 3 units. C-L: see Public Policy Studies 311

320. Macroeconomic Analysis I. Intertemporal models of consumption and labor supply; implications of these models for the behavior of macroeconomic aggregates, fiscal policy, and monetary policy; money demand and inflation; economic growth. Restricted to Ph.D. students in economics except with consent of instructor and director of graduate studies. Instructor: Burnside and Peretto. 3 units.

320D. Macroeconomic Analysis I. Same in content as Economics 320, but with weekly discussion section. Instructors: Burnside and Peretto. 3 units.

322. Macroeconomic Analysis II. Further analysis of topics treated in Economics 320. Optimal economic growth; business
cycles. Issues in economic policy. Prerequisite: Economics 320. Instructor: Ilut or Bianchi. 3 units.

322D. Macroeconomic Analysis II. Same in content as Economics 322, but with weekly discussion section. Instructors: Ilut or Bianchi. 3 units.

327. Empirical Methods in Macroeconomics and Forecasting in Time Series Analysis. Examine the models and statistical techniques used to study time series data with special emphasis to application in macro. Three objectives: equip students who anticipate using times series data in doctoral research with tools for state-of-the-art empirical research; lay out econometric theory for time series analysis, with emphasis on recent developments; to analyze selected recent work in theoretical macro modeling with emphasis on empirical implication and analysis. Instructor: Rossi. 3 units.

341. Econometrics I. Matrix algebra, probability theory, and statistics used to develop methods for multiple regression analysis. Covers material up to generalized least squares estimation. Restricted to PhD students in economics, except with consent of instructor. Instructor: Bollerslev. 3 units.

341D. Econometrics I. Same in content as Economics 341, but with weekly discussion section. Instructors: Bugni. 3 units.

342. Econometrics II. Advanced multivariate regression analysis. Topics include panel data models, systems, limited dependent variables, discrete choice, and nonlinear estimation. Prerequisite: Economics 341. Instructor: Khan or staff. 3 units.

342D. Econometrics II. Same in content as Economics 342, but with weekly discussion section. Instructor: Khan or staff. 3 units.

343. Econometrics III. Asymptotic theory for finite dimensional parametric models. Topics include nonlinear maximum likelihood, nonlinear regression, extremum estimators, aspects of computation, hypothesis testing, and models with limited dependent variables. Prerequisite: Economics 342. Instructor: Tauchen. 3 units.

345. Applied Econometrics. Applications of current econometric methodology to empirical problems with an emphasis on applied microeconomics. Topics include limited dependent variable, longitudinal and panel data analysis, and duration models. Prerequisites: Economics 341 and 344. Instructor: Tarozzi. 3 units.

349. Empirical Methods in Finance/Financial Econometrics. Selected current empirical research topics in finance and related econometric methods. Focus on testing theories of asset price determination, exploring the interplay between economic theory, statistical assumptions about returns, and the relevant econometric techniques. Prerequisite: Economics 304 and 347, or equivalent course work with consent of instructor. Instructor: Bollerslev or Tauchen. 3 units.

350. Econometrics of Macroeconomic Time Series. Statistical analysis of economic time series. The temporal dependence in such data and the formulation of dynamic economic models combine to present some unique problems and consequently require the application of specialized methods. Focus on applications rather than on proving theorems. Different econometric methodologies applicable to specific problems in macroeconomics, monetary economics, and finance. Prerequisite: Economics 302, 322; corequisite: Economics 345. Instructor: Bollerslev. 3 units.

351. Empirical Microeconomics. Covers recent research in empirical microeconomics. Particular attention will be paid to applications that exploit insights from game theory, information economics, imperfect competition and other recent developments in microeconomics theory. Examples from industrial organization, public finance and labor economics will be discussed. Students will engage in an empirical research project as part of the course requirements. Prerequisite: Economics 303, 341, 342, 343. Instructor: Staff. 3 units.

354. Seminar: Labor and Economics of the Family. Theory and empirical applications of decision making when individuals within groups have conflicting interests. For households include all outcomes over which household members have preferences (allocations of time to home production, market work and leisure, expenditures on goods; investments in children's education, daycare, and health; transfers within and across generations. Matching models and search (or marriage/divorce) markets) and consequences for intra- and extra-household distributions, including the intra-family distribution of income, child support, health and mortality, births out of wedlock and productivity over life cycle. Emphasis on influence of legal frameworks (family law, taxes and transfers). Related courses Econ 355, 385A. Consent of instructor required. Instructor: McElroy. 3 units.

355. Seminar in Labor Economics. Instructor: Staff. 3 units.

356. Graduate Health Economics I. Survey course designed for students considering PhD research in health economics. Topics will include demand for health insurance, moral hazard, health as an investment, technological change, the principal-agent problem, occupational entry, and the supply of physician services. Prerequisite: Economics 243 and 301. Instructor: Sloan. 3 units.

357. Health Economics: Demand. Graduate level course in the Economics of Health. Emphasis on acquiring a set of tools and a framework within which to organize empirical analysis. Focus on decisions made by household members and the market for health insurance. Relevance for students interested in broader empirical microeconomic research. Instructor: Becker and Sloan. 3 units.

358. Seminar in Labor Market and Related Analysis. A survey of several topics in modern labor economics including human capital, signaling, static and dynamic labor supply, household production, labor contracts, search, the theory of equalizing differences, and discrimination. Instructor: Arcidiacono. 3 units.

360. Vocational Skills for Empiricists. Practical skills necessary to do empirical work. Emphasis on effective programming in STATA, Matlab, and other higher programming languages. Management of data sets, including trade-offs empirical
economists make when analyzing data. Assignment to attempt replication of the results of a paper published on a top economics journal. Intended for students who have completed the first year of the PhD program in Economics. Instructor: Staff. 3 units.

365. Seminar in International Trade Theory and Policy. Instructor: Connolly. 3 units.

366. International Macroeconomics. This course covers recent research papers at the frontier of the field; as a result, the specific issues covered in the course tend to change from one year to the next. Instructor: Staff. 3 units.

370. Real Analysis for Economists. Topics include metric spaces, continuity, convexity, fixed point theory and normed linear spaces. Intended for students who have completed the first year of the PhD program in Economics. Instructor: Graham or Staff. 3 units.

379. Natural Resource Economics. 3 units. C-L: see Environment 379

380. Graduate Economics Workshops. May be taken for multiple credit. Sections: .01 Applied Microeconomics; .02 International Economics; .03 Field-specific Applied Microeconomics; .04 Applied Macroeconomics; .05 Economic History; .06 History of Political Economics; .07 Trade Dynamics Macroeconomics; .08 Econometrics; .09 Microeconomic Theory; .10 First-year Research. Instructor: Staff. 3 units.

380A. Applied Microeconomics Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to applied microeconomics. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380B. Macroeconomics and International Economics Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to macroeconomics and international economics. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380C. Specific Fields within Applied Microeconomics Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to specific fields within Applied Microeconomics. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380D. Economic History Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to economic history. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380E. Economic Thought/History of Political Economy Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to Economic Thought/History of Political Economy. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380F. Trade Dynamics Macroeconomic Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to Trade Dynamics Macro. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380G. Econometrics Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to Econometrics. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380H. Microeconomic Theory Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to microeconomic theory. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380J. 1st Year Introduction to Research. Discuss and analyze in detail recent papers drawn from literature relevant to various areas of Economics. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

380K. Applied Microeconomic Development Research. Discuss and analyze in detail recent papers drawn from literature relevant to applied microeconomic development research. Workshop serves as formal environment in which outside speakers present cutting edge research papers and Duke Ph.D. students present and evaluate their research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Instructor: staff. 3 units.

385A. Applied Microeconomics Research. For students anticipating working on thesis in area of Applied Microeconomics.
Emphasis on reading and critiquing state of the art empirical work in microeconomics and presenting ongoing graduate student research. Students expected to contribute to discussion and present on regular basis. Prerequisite: Econ 380 concurrently. Instructors: Arcidiacono, McElroy, Nechyba, Sloan, and Tarozzi. 1.5 units.

**385E. Research Seminar in Microeconometrics.** Facilitate research in applied microeconomics. Students and faculty present paper by leading research. Emphasis places on those papers that combine sophisticated techniques from econometrics and that integrate theory and empirical work. Participants encourage to present early version of own research. Prerequisite: Economics 380 taken concurrently. Instructor: Staff. 1.5 units.

**385F. Research Seminar in Financial Econometrics.** For students anticipating working on thesis in the area of financial econometrics. Emphasis on research that combines sophisticated statistical and econometric techniques with current ideas and issues in asset pricing finance. Students expected to contribute to discussions and present ongoing research on a regular basis. Prerequisites: Field Examinations in Econometrics and Finance, Econ 380 taken concurrently. Instructors: Bollerslev and Tauchen. 1.5 units.

**385M. Macroeconomics International Finance Research.** Discuss and analyze in detail recent papers on Macroeconomics and International Finance. Serves as formal environment in which students present and evaluate research on a regular basis. Participants required to make presentations as directed by instructor and play active role in discussions. Prerequisite: Economics 380 taken concurrently. Instructors: Burnside, Connolly, Kimbrough, Peretto, Rubio-Ramirez. 1.5 units.

**385T. Research Seminar in Economics Theory.** Student's own field and research papers will be used as basis for developing modeling skills in microeconomic theory including Contract Theory, Decision Theory, Game Theory, General Equilibrium, Industrial Organization, Mechanism Design, political economy, and Public Economics. Explore and develop methods and techniques for deriving economically interesting implications of assumptions on primitives. Write and refine original research papers, present work, and evaluate fellow students in route to dissertation prospectus. Prerequisite: Economics 380 taken concurrently. Instructors: Graham, Kranton, Taylor, and Yildirim. 1.5 units.

**385U. Urban and Environmental Economics Lab.** Focus on research questions at the confluence of urban and environmental economics. Addresses broader questions about the operation of housing markets, hedonic equilibrium, residential sorting, and applications to other local public goods and bads. Emphasis on discussing current research activities (including data and methods) in a lab setting designed to foster spillovers between participants. Instructor: Timmins. 1.5 units.

**388. Industrial Organization.** Analysis of models of markets, especially oligopoly. Game theoretic models of entry deterrence and predation. Product selection and advertising and other selected topics. Instructor: Grabowski or Yildirim. 3 units.

**389. Empirical Industrial Organization.** Intended for Ph.D. students interested in conducting research in empirical IO. Discuss estimation and applications of several broad classes of models: 1. Models of product differentiation 2. Static games of imperfect competition 3. Dynamic games of imperfect competition 4. Auctions 5. Principal agent models. Special attention will be paid to most recent research so students are exposed to papers on research frontier. Goal is to provide students with set of tools to write original research in empirical IO. Instructor: Staff. 3 units.

**391. European Economic History.** (Same as Economics 291, but requires an additional paper.) Not open to students who have taken Economics 291. Instructor: Tonio. 3 units.

**395. Special Topics in Economics.** Instructor: Staff. Variable credit.

**395A. Special Topics in Applied Microeconomics.** Instructor: Staff. Variable credit.

**395E. Special Topics in Econometrics.** Instructor: Staff. Variable credit.

**395F. Special Topics in Financial Econometrics.** Instructor: Staff. Variable credit.

**395M. Special Topics in Macro International Finance.** Instructor: Staff. Variable credit.

**395T. Special Topics in Economic Theory.** Instructor: Staff. Variable credit.

**398. Directed Research.** Consent of the director of graduate studies and instructor required. Instructor: Staff. Variable credit.

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**Education Policy Research**

**Professor Costanzo, Director of Graduate Studies**

A certificate is available in this program.

The goal of this interdisciplinary program is to train doctoral students who are already enrolled in a behavioral science discipline at Duke University to conduct research on complex problems in education policy. Problems such as student accountability systems, minority achievement gaps, teacher labor market distribution, and incentives in education require multiple disciplinary perspectives to solve. Faculty in the fields of economics, sociology, psychology, political science, history, and social work have collaborated to address such problems. Doctoral students are trained to: 1) understand the methods, theories, and body of knowledge from other disciplines; 2) understand the unique contribution that one's own discipline can make to solving complex problems; 3) work in multi-disciplinary teams to conduct research; and 4) write for diverse audiences that include scholars in other disciplines and policymakers.

Program requirements include attendance at a weekly seminar that includes faculty from diverse disciplines; a summer research assistantship with a faculty mentor from outside of one's own discipline; course work that broadens
the student's perspective on problems in education policy; and a dissertation in the area. This program is designed for doctoral students who intend to pursue an academic career conducting research on problems related to education.

This program is restricted to current Duke University students who have already completed at least one year of a doctoral program at Duke in a discipline such as economics, psychology, sociology, history, political science, or public policy.

Requirements:
Restricted to current Duke students who have already completed at least one year of a doctoral program at Duke in a discipline (such as Economics, Psychology, Sociology, History, or Political Science), who intend to pursue an academic career conducting research on problems relating to education.

• Requires weekly seminar attendance (faculty from diverse disciplines).
• Summer research assistantship with a faculty mentor from outside of one’s own discipline.
• Course work that broadens the student’s perspective on problems in education policy.
• Dissertation in the area.


Engineering
Professor Johnson, Dean (305 Teer Engineering Library Building); Professor Laursen, Senior Associate Dean for Education (305 Teer Engineering Library Building); Associate Professor Franzoni, PhD, Associate Dean for Student Affairs (305 Teer Engineering Library Building)

The Pratt School of Engineering offers programs of study and research leading to the MS and PhD degrees in biomedical engineering, civil and environmental engineering, electrical and computer engineering, and mechanical engineering and materials science. These programs are designed to provide: (1) development of depth and breadth in mathematics, computer science, the basic physical sciences, the life sciences where appropriate, and the engineering sciences; (2) mastery of an advanced body of knowledge in the candidate’s chosen field of specialization or research; (3) experience in the art of engineering, including strong elements of intuition, imagination, and judgment; and (4) performance of original research that, in the case of the MS degree, demonstrates the ability to advance knowledge in the area of professional study and, in the case of the PhD degree, makes a significant contribution to the research literature through publication in a leading professional journal in the field. Engineering graduate students are expected to participate in seminars appropriate to their fields of study. A minimum of 30 units of earned graduate credit beyond the bachelor’s degree is required for the MS degree: 12 in the major, 6 in related minor work (usually mathematics or natural science), 6 in either the major or minor subject or in other areas approved by the major department, and 6 for a research-based thesis. A non-thesis option requiring 30 units of course credit is available. Each of the departments imposes additional requirements in the exercise of this option. There is no language requirement for this degree. For the PhD degree in civil and environmental engineering, 15 units of approved course work are required in core courses, and 21 in related areas; in electrical engineering, 24 units are required in the major field and 12 units in a related minor field (often mathematics or natural science), 12 in either the major or minor subject or other areas approved by the major department, and 12 for a research-based dissertation. In biomedical and mechanical engineering and materials science there are no specific course requirements; each program is planned to meet individual needs. Doctoral students are required to pass qualifying and preliminary examinations, which may be either written, oral, or a combination of written and oral components, at the discretion of the committee and the department. In addition, the Pratt School of Engineering and the Fuqua School of Business offer an MBA/MS Joint Degree Program.

Additional information may be obtained by visiting our Web Site at: [http://www.pratt.duke.edu/](http://www.pratt.duke.edu/).

Biomedical Engineering
Professor Truskey, Chair; Professor Chilkoti, Director of Graduate Studies; Professors Barr, Chilkoti, R. Clark, Collins, Dewhurst, Friedman, Gauthier, Guilak, Henriquez, Izatt, Jaszcak, Johnson, Katz, Krassowska, Laursen, Leong, Myers, Needham, Nicoletis, Nolte, Reichert, Samei, Setton, S. Smith, Song, Trahey, Truskey, Vo-Dinh, von Ramm, and Zalutsky; Associate Professors Dobbins, Grill, MacFall, Ramanujam, Tornai, Wolf, Yuan; Assistant Professors Bursac, Idress, Lo, Mukundan, Nightingale, Tian, Wax, and You; Professors Emeriti H. Clark, Hammond, McElhaney, Plonsey; Associate Research Professor Bass; Assistant Research Professor Klitzman

Biomedical engineering is the discipline in which the physical, mathematical, and engineering sciences and associated technology are applied to biology and medicine. Contributions range from modeling and simulation of physiological systems through experimental research to solutions of practical clinical problems. The goal of the graduate program in biomedical engineering is to combine training in advanced engineering, biomedical engineering, and the life sciences so that graduates of the program can contribute at the most advanced professional level. The doctoral dissertation should demonstrate significant and original contributions to an interdisciplinary topic, accomplished as an independent investigator. The major, current research areas of the department are: biochemical engineering, biofluid mechanics, biomechanics, biomedical materials, biomedical modeling, biosensors, biotechnol-
ogy, data acquisition and processing, medical imaging, and electrophysiology. Every biomedical engineering graduate student is required to serve as a teaching assistant as part of the graduate training.

### Biomedical Engineering Courses (BME)

#### 201L. Electrophysiology (AC or GE)
The electrophysiology of excitable cells from a quantitative perspective. Topics include the ionic basis of action potentials, the Hodgkin-Huxley model, impulse propagation, source-field relationships, and an introduction to functional electrical stimulation. Students choose a relevant topic area for detailed study and report. Not open to students who have taken Biomedical Engineering 101L or equivalent. Instructor: Barr, Bursac, Grill, Henriquez, or Neu. 4 units. C-L: Neuroscience 201L

#### 202L. Fundamentals of Biomaterials and Biomechanics (AC or GE)
This course will cover principles of physiology, materials science and mechanics with particular attention to topics most relevant to biomedical engineering. Areas of focus include the structure-functional relationships of bioimplants including biological tissues and biopolymers; extensive treatment of the properties unique to biomaterials surfaces; behavior of materials in the physiological environment, and biomechanical failure criterion. The course includes selected experimental measurements in biomechanical and biomaterial systems. Prerequisites: Math 108; Engineering 75L or Biomedical Engineering 110L; Mechanical Engineering 83L or Biomedical Engineering 83L. Instructor: Staff. 3 units.

#### 204. Measurement and Control of Cardiac Electrical Events (GE, IM, EL)
Design of biomedical devices for cardiac application based on a review of theoretical and experimental results from cardiac electrophysiology. Evaluation of the underlying cardiac events using computer simulations. Examination of electrodes, amplifiers, pacemakers, and related computer apparatus. Construction of selected examples. Prerequisites: Biomedical Engineering 101L and 153L or equivalents. Instructor: Wolf. 3 units.

#### 206L. Elasticity (GE, BB)
Linear elasticity will be emphasized including concepts of stress and strain as second order tensors, equilibrium at the boundary and within the body, and compatibility of strains. Generalized solutions to two and three dimensional problems will be derived and applied to classical problems including torsion of noncircular sections, bending of curved beams, stress concentrations and contact problems. Applications of elasticity solutions to contemporary problem in civil and biomedical engineering will be discussed. Prerequisites: Biomedical Engineering 110L or Engineering 75L; Mathematics 108. Instructor: Laursen. 3 units. C-L: Civil Engineering 206

#### 207. Transport Phenomena in Biological Systems (AC or GE, BB)
An introduction to the modeling of complex biological systems using principles of transport phenomena and biochemical kinetics. Topics include the conservation of mass and momentum using differential and integral balances; rheology of Newtonian and non-Newtonian fluids; steady and transient diffusion in reacting systems; dimensional analysis; homogeneous versus heterogeneous reaction systems. Biomedical and biotechnological applications are discussed. Prerequisites: Biomedical Engineering 100L and Mathematics 108; or consent of the instructor. Instructor: Friedman, Katz, Truskey, or Yuan. 3 units. C-L: Civil Engineering 207, Mechanical Engineering and Materials Science 207

#### 208. Theoretical and Applied Polymer Science (GE, BB)
3 units. C-L: see Mechanical Engineering and Materials Science 211

#### 210. Molecular Basis of Membrane Transport (GE, MC, EL)
Transport of substances through cell membranes examined on a molecular level, with applications of physiology, drug delivery, artificial organs and tissue engineering. Topics include organization of the cell membrane, membrane permeability and transport, active transport and control of transport processes. Assignments based on computer simulations, with emphasis on quantitative behavior and design. Prerequisites: Biology 25L or equivalent, Mathematics 107 or equivalent. Instructors: Friedman or Neu. 3 units. C-L: Neuroscience 240

#### 211. Theoretical Electrophysiology (GE, EL)
Advanced topics on the electrophysiological behavior of nerve and striated muscle. Source-field models for single-fiber and fiber bundles lying in a volume conductor. Forward and inverse models for EMG and ENG. Bidomain model. Model and simulation for stimulation of single-fiber and fiber bundle. Laboratory exercises based on computer simulation, with emphasis on quantitative behavior and design. Readings from original literature. Prerequisite: Biomedical Engineering 101L or 201L or equivalent. Instructor: Barr or Neu. 4 units. C-L: Neuroscience 241

#### 212L. Theoretical Electrocardiography (GE, EL)
Electrophysiological behavior of cardiac muscle. Emphasis on quantitative study of cardiac tissue with respect to propagation and the evaluation of sources. Effect of junctions, inhomogeneities, anisotropy, and presence of unbounded extracellular space. Bidomain models. Study of models of arrhythmia, fibrillation, and defibrillation. Electrocardiographic models and forward simulations. Laboratory exercises based on computer simulation, with emphasis on quantitative behavior and design. Readings from original literature. Prerequisite: Biomedical Engineering 101L or 201L or equivalent. Instructor: Barr. 4 units.

#### 213. Nonlinear Dynamics in Electrophysiology (GE, EL)
Electrophysiological behavior of excitable membranes and nerve fibers examined with methods of nonlinear dynamics. Phase-plane analysis of excitable membranes. Limit cycles and the oscillatory behavior of membranes. Phase resetting by external stimuli. Critical point theory and its applications to the induction of rotors in the heart. Theory of control of chaotic systems and stabilizing irregular cardiac rhythms. Initiation of propagation of waves and theory of traveling waves in a nerve fiber. Laboratory exercises based on computer simulations, with emphasis on quantitative behavior and design. Readings from original literature. Prerequisite: Mathematics 107 or equivalent. Instructor: Neu. 4 units.
215. Biomedical Materials and Artificial Organs (GE, BB). Chemical structures, processing methods, evaluation procedures, and regulations for materials used in biomedical applications. Applications include implant materials, components of ex vivo circuits, and cosmetic prostheses. Primary emphasis on polymer-based materials and on optimization of parameters of materials which determine their utility in applications such as artificial kidney membranes and artificial arteries. Prerequisite: Biomedical Engineering 83L and 100L or their equivalent or consent of instructor. Instructor: Reichert. 3 units.

216. Transport Phenomena in Cells and Organs (GE, MC). Applications of the principles of mass and momentum transport to the analysis of selected processes of biomedical and biotechnological interest. Emphasis on the development and critical analysis of models of the particular transport process. Topics include: reaction-diffusion processes, transport in natural and artificial membranes, dynamics of blood flow, pharmacokinetics, receptor-mediated processes and macromolecular transport, normal and neoplastic tissue. Prerequisite: Biomedical Engineering 207 or equivalent. Instructor: Truskey or Yuan. 3 units.

217. Cell Mechanics and Mechanotransduction. This course examines the mechanical properties of cells and forces exerted by cells in biological processes of clinical and technological importance and the processes by which mechanical forces are converted into biochemical signals and activate gene expression. Topics covered include measurement of mechanical properties of cells, cytoskeleton mechanics, models of cell mechanical properties, cell adhesion, effects of physical forces on cell function, and mechanotransduction. Students will critically evaluate current literature and analyze models of cell mechanics and mechanotransduction. Prerequisites: Engineering 75 and Biomedical Engineering 207 or equivalent, knowledge of cell biology and instructor consent. Instructor: Truskey. 3 units.

220L. Introduction to Biomolecular Engineering (GE, BB, MC). Structure of biological macromolecules, recombinant DNA techniques, principles of and techniques to study protein structure-function. Discussion of biomolecular design and engineering from the research literature. Linked laboratory assignments to alter protein structure at the genetic level. Expression, purification, and ligand-binding studies of protein function. Consent of instructor required. Instructor: Chilkoti. 3 units.

221. Modeling and Engineering Gene Circuits. This course discusses modeling and engineering gene circuits, such as prokaryotic gene expression, cell signaling dynamics, cell-cell communication, pattern formation, stochastic dynamics in cellular networks and its control by feedback or feedforward regulation, and cellular information processing. The theme is the application of modeling to explore "design principles" of cellular networks, and strategies to engineer such networks. Students need to define an appropriate modeling project. At the end of the course, they're required to write up their results and interpretation in a research-paper style report and give an oral presentation. Prerequisites: Biomedical Engineering 100L or consent of instructor. Instructor: Chilkoti. 3 units.

222. Principles of Ultrasound Imaging (GE, IM). Propagation, reflection, refraction, and diffraction of acoustic waves in biologic media. Topics include geometric optics, physical optics, attenuation, and image quality parameters such as signal-to-noise ratio, dynamic range, and resolution. Emphasis is placed on the design and analysis of medical ultrasound imaging systems. Prerequisites: Mathematics 107 and Physics 62L. Instructor: von Ramm. 3 units.

227L. Design in Biotechnology (DR or GE, MC, BB). Design of custom strategies to address real-life issues in the development of biocompatible and biomimetic devices for biotechnology or biomedical applications. Student teams will work with a client in the development of projects that incorporate materials science, biological transport and biomechanics. Formal engineering design principles will be emphasized; overview of intellectual properties, engineering ethics, risk analysis, safety in design and FDA regulations will be reviewed. Oral and written reports, and prototype development will be required. This course is intended as a capstone design course for the upper-level undergraduate biomedical engineering students with a focused interest in bimolecular science, biotechnology, transport, drug delivery, biomechanics and related disciplines. Prerequisites: BME 207, Statistics 113, or equivalent. Instructors: Gimm. 3 units.

228. Laboratory in Cellular and Biosurface Engineering (GE, MC). Introduction to common experimental and theoretical methodologies in cellular and biosurface engineering. Experiments may include determination of protein and peptide diffusion coefficients in alginate beads, hybridoma cell culture and antibody production, determination of the strength of cell adhesion, characterization of cell adhesion or protein adsorption by total internal reflection fluorescence, and Newtonian and non-Newtonian rheology. Laboratory exercises are supplemented by lectures on experiment design, data analysis, and interpretation. Prerequisites: Biomedical Engineering 207 or equivalent. Instructor: Truskey. 3 units.

230. Tissue Biomechanics (GE, BB). Introduction to the mechanical behaviors of biological solids and fluids with application to tissues, cells and molecules of the musculoskeletal and cardiovascular systems. Topics to be covered include static force analysis and optimization theory, biomechanics of linearly elastic solids and fluids, anisotropic behaviors of bone and fibrous tissues, blood vessel mechanics, cell mechanics and behaviors of single molecules. Emphasis will be placed on modeling stress-strain relations in these tissues, and experimental devices used to measure stress and strain. Student seminars on topics in applied biomechanics will be included. Prerequisites: Biomedical Engineering 110L or Engineering 75L; Mathematics 108. Instructor: Myers or Setton. 3 units.

231. Intermediate Biomechanics (GE, BB). Introduction to solid and orthopaedic biomechanical analyses of complex tissues and structures. Topics to be covered include: spine biomechanics, elastic modeling of bone, linear and quasi-linear viscoelastic properties of soft tissue (for example, tendon and ligament), and active tissue responses (for example, muscle). Emphasis will be placed on experimental techniques used to evaluate these tissues. Student seminars on topics in applied biomechanics will
be included. Prerequisites: Biomedical Engineering 110L or Engineering 75L; Mathematics 108. Instructor: Myers or Setton. 3 units.

233. Modern Diagnostic Imaging Systems (AC or GE). The underlying concepts and instrumentation of several modern medical imaging modalities. Review of applicable linear systems theory and relevant principles of physics. Modalities studied include X-ray radiography (conventional film-screen imaging and modern electronic imaging), computerized tomography (including the theory of reconstruction), and nuclear magnetic resonance imaging. Prerequisite: Biomedical Engineering 171, junior or senior standing. Consent of instructor required. Instructor: Smith or Trahey. 3 units.

233A. Modern Medical Diagnostic Imaging Systems. This course covers the mathematics, physics, and instrumentation of several modern medical imaging modalities starting with a review of applicable linear systems theory and relevant principles of physics. Modalities studied include X-ray photography (film-screen and electronic), computerized tomography, ultrasound and nuclear magnetic resonance imaging. Consent of instructor required. Instructor: MacFall. 3 units.

235. Acoustics and Hearing (GE, IM). The generation and propagation of acoustic (vibrational) waves and their reception and interpretation by the auditory system. Topics under the heading of generation and propagation include free and forced vibrations of discrete and continuous systems, resonance and damping, and the wave equation and solutions. So that students may understand the reception and interpretation of sound, the anatomy and physiology of the mammalian auditory system are presented; and the mechanics of the middle and inner ears are studied. Prerequisites: Biomedical Engineering 171 or equivalent and Mathematics 107. Instructor: Collins or Trahey. 3 units. C-L: Electrical and Computer Engineering 284

236L. Biophotonic Instrumentation (DR or GE, IM). Theory and laboratory practice in optics, and in the design of optical instruments for biomedical applications. Section I focuses on basic optics theory and laboratory practice. Section II focuses on deeper understanding of selected biophotonic instruments, including laboratory work. Section III comprises the design component of the course. In this part, student teams are presented with a design challenge, and work through the steps of engineering design culminating in building a prototype solution to the design challenge. Lecture topics include engineering design, intellectual property protection, engineering ethics, and safety. Prerequisites: Biomedical Engineering 154L and Statistics 113. Instructor: Izatt or Wax. 3 units.

237. Biosensors (GE, IM, MC). Biosensors are defined as the use of biospecific recognition mechanisms in the detection of analyte concentration. The basic principles of protein binding with specific reference to enzyme-substrate, lectin-sugar, antibody-antigen, and receptor-transmitting binding. Simple surface diffusion and absorption physics at surfaces with particular attention paid to surface binding phenomena. Optical, electrochemical, gravimetric, and thermal transduction mechanisms which form the basis of the sensor design. Prerequisites: Biomedical Engineering 83L and 100L or their equivalent and consent of instructor. Instructor: Reichert or Vo-Dinh. 3 units.

239. Cell Transport Mechanisms (GE, MC). Analysis of the migration of cells through aqueous media. Focus on hydrodynamic analysis of the directed self-propulsion of individual cells, use of random walk concepts to model the nondirected propulsion of individual cells, and development of kinetic theories of the migrations of populations of cells. Physical and chemical characteristics of the cells' environments that influence their motion, including rheologic properties and the presence of chemotactic, stimulatory, or inhibitory factors. Cell systems include mammalian sperm migration through the female reproductive tract, protozoa, and bacteria. Emphasis on mathematical theory. Experimental designs and results. Prerequisites: Biomedical Engineering 207 and consent of instructor. Instructor: Katz. 3 units.

240L. Environmental Molecular Biotechnology (GE, MC). 3 units. C-L: see Civil Engineering 239L

242L. Introduction to Bionanotechnology Engineering. A general overview of nanoscale science/physical concepts will be presented as those concepts tie in with current nanoscience and nanomedicine research. Students will be introduced to the principle that physical scale impacts innate material properties and modulates how a material interacts with its environment. Important concepts such as surface-to-volume ratio, friction, electronic/optical properties, self-assembly (biological and chemical) will be contextually revisited. A number of laboratory modules ("NanoLabs") will guide students through specific aspects of nanomedicine, nanomaterials, and engineering design. Prerequisites: BME 83L and BME 100L or consent of instructor. 3 units.

246. Computational Methods in Biomedical Engineering (GE). Introduction to practical computational methods for data analysis and simulation with a major emphasis on implementation. Methods include numerical integration and differentiation, extrapolation, interpolation, splining, FFTs, convolution, ODEs, and simple one- and two-dimensional PDEs using finite differencing. Introduction to concepts for optimizing codes on a CRAY-YMP. Examples from biomechanics, electrophysiology, and imaging. Project work included and students must have good working knowledge of Unix, Fortran, or C. Intended for graduate students and seniors who plan on attending graduate school. Prerequisite: Engineering 53L or equivalent, Mathematics 107 or equivalent, or consent of instructor. Instructor: Henriquez. 3 units.

247. Drug Delivery (GE, BB, MC). Introduction to drug delivery in solid tumors and normal organs (for example, reproductive organs, kidney, skin, eyes). Emphasis on quantitative analysis of drug transport. Specific topics include: physiologically-based pharmacokinetic analysis, microcirculation, network analysis of oxygen transport, transvascular transport, interstitial transport, transport across cell membrane, specific issues in the delivery of cells and genes, drug delivery systems, and targeted drug delivery. Prerequisite: Biomedical Engineering 207 and Engineering 53. Instructor: Yuan. 3 units.

248. Tissue Engineering (GE, MC). This course will serve as an overview of selected topics and problems in the emerging field of tissue engineering. General topics include cell sourcing and maintenance of differentiated state, culture scaffolds, cell-
biomaterials interactions, bioreactor design, and surgical implantation considerations. Specific tissue types to be reviewed include cartilage, skin equivalents, blood vessels, myocardium and heart valves, and bioartificial livers. Prerequisites: Mathematics 108 or consent of instructor. Instructor: Bursac. 3 units.

351. Seminars in Medical Physics. Medical physics is the application of the concepts and methods of physics and engineering to the diagnosis and treatment of human disease. This course consists of weekly lectures covering broad topics in medical physics including diagnostic imaging, radiation oncology, radiation safety, and nuclear medicine. Lectures will be given by invited speakers drawn from many university and medical center departments including Biomedical Engineering, radiology, physics, radiation safety, and radiation oncology. Prerequisites: background in engineering or physics. 1 CC (0.5 ES/0.5 ED). Consent of instructor required. Instructor: Lo and Samei. 1 unit.

252. Neural Signal Acquisition (GE, IM, EL). This course will be an exploration of analog and digital signal processing techniques for measuring and characterizing neural signals. The analog portion will cover electrodes, amplifiers, filters and A/D converters for recording neural electrograms and EEGs. The digital portion will cover methods of EEG processing including spike detection and spike sorting. A course pack of relevant literature will be used in lieu of a textbook. Students will be required to write signal-processing algorithms. Prerequisite: Biomedical Engineering 154L. Instructor: Wolf. 3 units. C-L: Neuroscience 252

253. Computational Neuroengineering (GE, EL). This course introduces students to the fundamentals of computational modeling of neurons and neuronal circuits and the decoding of information from populations of spike trains. Topics include: integrate and fire neurons, Spike Response Models, Homogeneous and Inhomogeneous Poisson processes, neural circuits, Weiner (optimal), Adaptive Filters, neural networks for classification, population vector coding and decoding. Programming assignments and projects will be carried out using MATLAB. Prerequisites: BME 101/201 or equivalent. Instructor: Henriquez. 3 units. C-L: Neuroscience 253

254. Fundamentals of Electrical Stimulation of the Nervous System (GE, EL). This course presents a quantitative approach to the fundamental principles, mechanisms, and techniques of electrical stimulation required for non-damaging and effective application of electrical stimulation. Consent of instructor required. Instructor: Grill. 3 units.

256. Neural Prosthetic Systems. This course will cover several systems that use electrical stimulation or recording of the nervous system to restore function following disease or injury. For each system the course will cover the underlying biophysical basis for the treatment, the technology underlying the treatment, and the associated clinical applications and challenges. Systems to be covered include cochlear implants, spinal cord stimulation of pain, vagus nerve stim. for epilepsy, deep brain stim. for movement disorders, sacral root stim. for bladder dysfunction, and neuromuscular electrical stim. for restoration of movement. Prerequisites: Biomedical Engineering 101L, Biomedical Engineering 153L, and consent of instructor. Instructor: Grill. 3 units.

258L. Genome Science & Technology Lab (GE, MC). Hands-on experience on using and developing advanced technology platforms for genomics and proteomics research. Experiments may include nucleic acid amplification and quantification, lab-on-chip, bimolecular separation and detection, DNA sequencing, SNP genotyping, microarrays, and synthetic biology techniques. Laboratory exercises and designing projects are combined with lectures and literature reviews. Prior knowledge in molecular biology and biochemical engineering is required. Instructor consent required. Instructor: Tian. Variable credit. C-L: Computational Biology and Bioinformatics 222

260L. Devices for People with Disabilities (DR or GE, IM, BB). Design of custom devices to aid disabled individuals. Students will be paired with health care professionals at local hospitals who will supervise the development of projects for specific clients. Formal engineering design principles will be emphasized; overview of assistive technologies, patent issues, engineering ethics. Oral and written reports will be required. Selected projects may be continued as independent study. Prerequisite: Biomedical Engineering 154L and Statistics 113. Instructor: Bohs or Goldberg. 3 units.

261L. Electronic Designs for the Developing World (DR or GE, IM). Design of custom devices to help the specific and unique needs of developing world hospitals. Formal engineering design principles will be emphasized; overview of developing world conditions, patent issues, engineering ethics. Designs must be based on microcontroller or equivalent electronic circuitry. Oral and written reports will be required. Students may elect to personally deliver their projects to a developing world hospital, if selected, in the summer following the course. Prerequisites: Biomedical Engineering 154L and Statistics 113. Consent of instructor required. Instructor: Malkin. 3 units.

262L. Design for the Developing World (DR or GR). Design of custom devices to help the specific and unique needs of developing world hospitals. Formal engineering design principles will be emphasized; overview of developing world conditions, patent issues, engineering ethics. Oral and written reports will be required. Students may elect to personally deliver their projects to a developing world hospital, if selected, in the summer following the course. Prerequisite: Biomedical Engineering 154L and Statistics 113. Instructor: Malkin. 3 units.

264L. Medical Instrument Design (DR or GE, IM). General principles of signal acquisition, amplification processing, recording, and display in medical instruments. System design, construction, and evaluation techniques will be emphasized. Methods of real-time signal processing will be reviewed and implemented in the laboratory. Each student will design, construct, and demonstrate a functional medical instrument and collect and analyze data with that instrument. Formal write-ups and presentations of each project will be required. Prerequisite: Biomedical Engineering 154L and Statistics 113, or equivalent or senior standing. Instructor: Malkin, S. Smith, Trahey, or Wolf. 4 units.
265. Advanced Topics in Biomedical Engineering. Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required. Instructor: Staff. 3 units.

265L. Advanced Topics with Lab. To be used as a "generic" course number for any advanced topics course with lab sections. Instructor: Staff. 3 units.

351. Seminars in Medical Physics. Medical physics is the application of the concepts and methods of physics and engineering to the diagnosis and treatment of human disease. This course consists of weekly lectures covering broad topics in medical physics including diagnostic imaging, radiation oncology, radiation safety, and nuclear medicine. Lectures will be given by invited speakers drawn from many university and medical center departments including Biomedical Engineering, radiology, physics, radiation safety, and radiation oncology. Prerequisites: background in engineering or physics. 1 CC (0.5 ES/0.5 ED). Consent of instructor required. Instructor: Lo and Samei. 1 unit.

370. Graduate Seminars in BME. Graduate seminars in BME. Discussions on topics of interests to BME graduate students. Instructor: Staff. 1 unit.

275. Introduction to Biofluid Mechanics. Methods and applications of fluid mechanics in biological and biomedical systems including: Governing equations and methods of solutions (e.g., conservation of mass flow and momentum), the nature of biological fluids, (e.g., non-Newtonian rheological behavior), basic problems with broad relevance, (e.g., flow in pipes, lubrication theory), applications to cells and organs in different physiological systems, (e.g., cardiovascular, gastrointestinal, respiratory, reproductive and musculoskeletal systems), applications to diagnosis and therapy, (e.g., drug delivery and devices). Prerequisite: Biomedical Engineering 207. Instructor: Katz. 3 units.

301. Biological Engineering Seminar Series (CBIMMS and CBTE). 1 unit. C-L: see Mechanical Engineering and Materials Science 301


311. BME Graduate Seminars. Two semester, weekly seminars series required of all BME graduate students. Students are exposed to the breadth of research topics in BME via seminars given by BME faculty, advanced graduate students, and invited speakers. At the end of each semester students are required to write a synopsis of the seminars attended. More than three unexcused absences will result in a failing grade. Instructor: Staff. 0 units.

315. Advanced Biomedical Imaging Seminar. Variable credit. C-L: see Chemistry 315

320. Medical Ultrasound Transducers. A study of the design, fabrication, and evaluation of medical ultrasound transducers. Topics include wave propagation in piezoelectric crystals, Mason and KLM circuit models, linear arrays and two-dimensional arrays, piezoelectric ceramic/epoxy composite materials, piezoelectric polymers, and photo-acoustic materials. Consent of instructor required. Instructor: S. Smith. 3 units.

321. Advanced Ultrasonic Imaging. This course provides students with a mathematical basis of ultrasonic imaging methods. Topics include K-space, descriptions of ultrasonic imaging, ultrasonic beam-former design, tissue motion and blood flow imaging methods, and novel ultrasonic imaging methods. Students conduct extensive simulations of ultrasonic imaging methods. Prerequisite: Biomedical Engineering 233. Instructor: Trahey. 3 units.

329. Continuum Biomechanics. Introduction to conservation laws and thermodynamic principles of continuum mechanics with application to tissues of the musculoskeletal and cardiovascular systems. Topics cover nonlinear and anisotropic behaviors of solids and fluids. Emphasis on the application of hyperelastic constitutive formulations to determination of stress and strain fields in deformations of calcified tissues (e.g., connective, cortical and trabecular bone), soft tissues (e.g., example, ligament, cartilage, cornea, intervertebral disc, left ventricle, aorta), and biological fluids (e.g., mucus, synovial fluid, polymer solutions). Tensor fields and indicial notation. Prerequisites: Biomedical Engineering 110L or Engineering 75L or equivalent, and Mathematics 111 or equivalent. Instructor: Setton. 3 units.

330. Finite Element Method for Biomedical Engineers. The finite element method with an emphasis on applications to biomedical engineering. Several detailed examples illustrate the finite element analysis process, which includes setting up a mathematical description of the problem, putting it into a form suitable for finite element solution, solving the discretized problem, and using advanced computer codes to check the correctness of the numerical results. Consent of instructor required. Instructor: Staff. 3 units.


333. Biomedical Imaging. A study of the fundamentals of information detection, processing, and presentation associated with imaging in biology and medicine. Analysis of coherent and incoherent radiation and various image generation techniques. Design and analysis of modern array imaging systems as well as systems. Instructor: von Ramm. 3 units.

334L. Radiology in Practice. Designed to complement BME 233 Modern Diagnostic Imaging Systems. Review and real-life exercises on principles of modern medical imaging systems with emphasis on the engineering aspects of image acquisition, reconstruction and visualization, observations of imaging procedures in near clinical settings, and hands-on experience with the instruments. Modalities covered include ultrasound, CT, MRI, nuclear medicine and optical imaging. Prerequisite: BME
335. **Advances in Photonics: An Overview of State-of-the-Art Techniques and Applications.** The main goal of this course is to provide and overview of various photonics techniques and their applications. The purpose is to enhance the students' breadth of understanding and knowledge of advanced techniques and introduce them to the wide variety of applications in photonics, the science and technology associated with interactions of light with matter. Examples of topics include: High-resolution Luminescence Techniques, Raman Techniques, Optical Coherence Techniques, Ultrafast Laser-base Techniques, Near-Filed and Confocal Optical Techniques, Remote Sensing Techniques, Advanced Light Measurement Techniques, Optical Biosensors, Nano Micro Electrooptics Systems, Highthroughput Assays using Optical Detection, Photonics Meta Materials and Applications, Optics in Telecommunications, and Nanophotonics. The lectures will be presented by faculty members who are leaders in their areas of research in photonics. Instructor: Vo-Dinh. 3 units. C-L: Chemistry 335

340. **Mechanics of Multiphase Biological Tissues.** Introduction to constitutive modeling of multiphase mixtures with application to biological tissues (for example, skin, cornea, ligament, cartilage, intervertebral disc). Fundamental conservation laws and thermodynamic principles of the theory of mixtures will be reviewed. Development of constitutive equations for mixtures containing inviscid and viscous fluids, as well as hyperelastic, viscoelastic, and charged solids. Emphasis on solution methods required to determine the stress, strain, and flow fields in boundary value problems of simplified geometries, including problems for contact of two bodies. A knowledge of tensor fields, indicial notation, and partial differential equations is required. Prerequisite: Mathematics 114 or equivalent, and Biomedical Engineering 229 or consent of instructor. Instructor: Setton. 3 units.

350. **Principles of Research Management.** A survey of topics in modern research management techniques that will cover proven successful principles and their application in the areas of research lab organization, resource management, organization of technical projects, team leadership, financial accountability, and professional ethics. Instructor: Staff. 1 unit.

360. **Leading Medical Devices: Innovation to Market.** Interdisciplinary examination of the medical device landscape for business, engineering, and medicine. Provides core tools for individuals interested in product design and development. Includes market definition and modeling, financing, reimbursement, business plan modeling, and the global marketplace. Case-based and team-based learning including developing a business plan and 510K approval will augment core instruction and guest lecturers. Consent of instructor required. Instructor: Chopra. 3 units.

362. **Invention to Application: Healthcare Research Commercialization.** Interdisciplinary teams of students from engineering, medical science, business, and medicine work together to understand and evaluate the commercial potential of Duke faculty research innovations and develop a comprehensive research translation and business plan for one chosen opportunity. Learning includes understanding technology, product development, marketing, finance, regulatory requirements, and reimbursement. In addition to weekly lectures, students are mentored in this real world experience by a team including technology transfer experts, venture capitalists, researchers, physicians, and entrepreneurs. Prerequisites: none. Consent of instructor required. Instructor: Myers, Uzbil. 3 units.

365. **Advanced Topics for Graduate Students in Biomedical Engineering.** Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required. Instructor: Staff. 3 units.

399. **Special Readings in Biomedical Engineering.** Individual readings in advanced study and research areas of biomedical engineering. Approval of director of graduate studies required. 1 to 3 units each. Instructor: Staff. Variable credit.

**Civil and Environmental Engineering**

Professor Albertson, Chair (121 Engineering); Associate Professor of the Practice Schaad, Associate Chair; Professor Dolbow, Director of Graduate Studies; Professors Albertson, Barros, Deshusses, Dolbow, Hueckel, Laursen, Medina, Petroski, Porporato, Virgin, Wiesner; Associate Professors Boaud, Ferguson, Gavin, Kabala, Peirce; Assistant Professors Gunsch, Hsu-Kim, Khlystov, Scruggs; Associate Professors of the Practice Nadeau and Schaad; Professors Emeriti Brown and Wilson; Adjunct Associate Professor Linden; Adjunct Assistant Professor Schuler; Lecturer Brasier; Secondary Appointments: Professors Haff (geology), Malin (seismology), Reckhow (water resources), Trangenstein (mathematics), Vallero (engineering ethics); Associate Professor Kasibhatla (environmental chemistry); Assistant Professor of the Practice Goodall (geospatial analysis)

The Department of Civil and Environmental Engineering (CEE) at Duke University offers programs of study and research leading to the MS and PhD degrees with a major in Civil and Environmental Engineering. CEE pursues diverse research and educational activities to improve the fundamental safety, health, and quality of life in our society. These activities focus on three broad areas: (1) materials, structures, and geo-systems; (2) hydrology and fluid dynamics; and, (3) environmental process engineering.

Overlapping at times, these areas represent the three tracks of study offered by our graduate faculty. The specific areas include engineering mechanics, computational mechanics, geo-materials and environmental geo-mechanics, engineering and environmental geophysics, structural engineering, water resources engineering, hydrology, environmental fluid dynamics, and environmental process engineering aspects of water, atmosphere, and soil pollution.

Current research in these areas focuses on new computational paradigms for complex mechanical systems, including contact, fracture and damage problems; environmental geomechanics and geophysics; adaptive materials
and structures and their use in structural dynamics; microstructured materials; deterministic and stochastic water resources and contaminant hydrology; global and regional water cycle; ocean-land-atmosphere interactions; biological and chemical aspects of pollution and its remediation in water, air, and soil.

**Civil Engineering Courses (CE)**

200. **Engineering Data Analysis.** Introduction to the statistical error analysis of imprecise data and the estimation of physical parameters from data with uncertainty. Interpolation and filtering. Data and parameter covariance. Emphasis on time series analysis in the time- and frequency-domains. Linear and nonlinear least squares. Confidence intervals and belts. Hypothesis testing. Introduction to parameter estimation in linear and nonlinear dynamic systems. Prerequisite: graduate standing or instructor consent. Instructors: Boadu, Gavin, or Porporato. 3 units.


202. **Applied Mathematics for Engineers.** Advanced analytical methods of applied mathematics useful in solving a wide spectrum of engineering problems. Applications of linear algebra, calculus of variations, the Frobenius method, ordinary differential equations, partial differential equations, and boundary value problems. Prerequisites: Math 108 or equivalent and undergraduate courses in solid and/or fluid mechanics. Instructor: Kabala. 3 units.


204. **Plates and Shells.** Differential equation and extremum formulations of linear equilibrium problems of Kirchhoffian and non-Kirchhoffian plates of isotropic and aelotropic material. Solution methods. Differential equation formulation of thin aelotropic shell problems in curvilinear coordinates; membrane and bending theories; specialization for shallow shells, shells of revolution, and plates. Extremum formulation of shell problems. Solution methods. Prerequisites: Engineering 75L or 135 and Mathematics 108. Instructor: Virgin. 3 units. C-L: Mechanical Engineering and Materials Science 204

205. **Mechanics of Composite Materials.** Theory and application of effective medium, or homogenization, theories to predict macroscopic properties of composite materials based on microstructural characterizations. Effective elasticity, thermal expansion, moisture swelling, and transport properties, among others, are presented along with associated bounds such as Voigt/Reuss and Hashin-Shtrikman. Specific theories include Eshelby, Mori-Tanaka, Kuster-Toksoz, self-consistent, generalized self-consistent, differential method, and composite sphere and cylinder assemblages. Tensor-to-matrix mappings, orientational averaging, and texture analysis. Composite laminated plates, environmentally induced stresses, and failure theories. Prerequisite: Civil Engineering 201 or consent of instructor. Instructor: Nadeau. 3 units.

206. **Elasticity (GE, BB).** 3 units. C-L: see Biomedical Engineering 206L

207. **Transport Phenomena in Biological Systems (AC or GE, BB).** 3 units. C-L: see Biomedical Engineering 207; also C-L: Mechanical Engineering and Materials Science 207

208. **Environmental Transport Phenomena.** Conservation principles in the atmosphere and bodies of water, fundamental equations for transport in the atmosphere and bodies of water, scaling principles, simplification, turbulence, turbulent transport, Lagrangian transport, applications to transport of particles from volcanoes and stacks, case studies: volcanic eruption, Chernobyl accident, forest fires and Toms River power plant emission. Instructor: Wiesner. 3 units.

210. **Intermediate Dynamics: Dynamics of Very High Dimensional Systems.** 3 units. C-L: see Mechanical Engineering and Materials Science 210

211. **Energy Flow and Wave Propagation in Elastic Solids.** Derivation of equations for wave motion in simple structural shapes: strings, longitudinal rods, beams and membranes, plates and shells. Solution techniques, analysis of systems behavior. Topics covered include: nondispersive and dispersive waves, multiple wave types (dilational, distortion), group velocity, impedance concepts including driving point impedances and moment impedances. Power and energy for different cases of wave propagation. Prerequisites: Engineering 123L and Mathematics 108 or consent of instructor. Instructor: Franzoni. 3 units. C-L: Mechanical Engineering and Materials Science 234


220. **Ecohydrology.** This course provides the theoretical basis for understanding the interaction between hydrologic cycle, vegetation and soil biogeochemistry which is key for a proper management of water resources and terrestrial ecosystems especially in view of the possible intensification and alteration of the hydrologic regime due to climate change. Topics include: probabilistic soil moisture dynamics, plant water stress; coupled dynamics of soil moisture, transpiration and photosynthesis; and infiltration, root uptake, and hydrologic control on soil biogeochemistry. Pre-requisite: Consent of instructor required. Instructor: Porporato. 3 units.
225. Dynamic Engineering Hydrology. Dynamics of the occurrence, circulation, and distribution of water; climate, hydrometeorology, geophysical fluid motions. Precipitation, surface runoff and stream flow, infiltration, water losses. Hydrograph analysis, catchment characteristics, hydrologic instrumentation, and computer simulation models. Prerequisite: Civil Engineering 122L or consent of instructor. Instructor: Medina. 3 units.


229. Introduction to Atmospheric Aerosol. Atmospheric aerosol and its relationship to problems in air control, atmospheric science, environmental engineering, and industrial hygiene. Open to advanced undergraduate and graduate students. Prerequisites: knowledge of calculus and college-level physics. Consent of instructor required. Instructor: Khlystov. 3 units.

230L. Aerosol Measurement Techniques for Air Quality Monitoring and Research. Principles of measurements and analysis of ambient particulate matter (aerosol). Traditional and emerging measurements techniques currently used in air quality monitoring and homeland defense. Open to advanced undergraduate and graduate students interested in the science and engineering related to atmospheric aerosol. Consent of the instructor required. Instructor: Khlystov. 3 units.

235. Aquatic Geochemistry. Geochemistry of the water-solid interface of soils, minerals, and particles in earth systems. Topics will cover a quantitative description of the chemical composition of soils, geochemical speciation, mindal weathering and stability, sorption and ion exchange, soil redox processes, and chemical kinetics at environmental surfaces. Pre-requisite: CE/ENVIRON 242 or CE 120L or permission of instructor. 3 units.

237. Advanced Soil Mechanics. Characterization of behavior of geomaterials. Stress-strain incremental laws. Nonlinear elasticity, hypo-elasticity, plasticity and visco-elasticity of geomaterials; approximated laws of soil mechanics; fluid-saturated soil behavior; cyclic behavior of soils; liquefaction and cyclic mobility; elements of soil dynamics; thermal effects on soils. Prerequisite: Civil Engineering 139L or equivalent. Instructor: Hueckel. 3 units.

238. Environmental Geomechanics. The course addresses engineered and natural situations, where mechanical and hydraulic properties of soils and rocks depend on environmental (thermal chemical, biological) processes. Experimental findings are reviewed, and modeling of coupled thermo-mechanical, chemo-mechanical technologies are reviewed. Instructor: Hueckel. 3 units.

239L. Environmental Molecular Biotechnology (GE, MC). Principles of genetics and recombinant DNA for environmental systems. Applications to include genetic engineering for bioremediation, DGGE, FISH, micro-arrays and biosensors. Laboratory exercises to include DNA isolation, amplification, manipulation and analysis. Prerequisites: CE 124L/BIO 25 or consent of the instructor. Instructor: Gunsch. 3 units. C-L: Biomedical Engineering 240L

240. Chemical Fate of Organic Compounds. 3 units. C-L: see Environment 240

241. Physical Chemical Processes in Environmental Engineering. Theory and design of fundamental and alternative physical and chemical treatment processes for pollution remediation. Reactor kinetics and hydraulics, gas transfer, adsorption, sedimentation, precipitation, coagulation/flocculation, chemical oxidation, disinfection. Prerequisites: introductory environmental engineering, chemistry, graduate standing, or permission of instructor. Instructor: Staff. 3 units.

242. Environmental Aquatic Chemistry. Principles of chemical equilibria and kinetics applied to quantitative chemical description of natural and engineered aquatic systems. Topics include acid/base equilibrium, the carbonate system, metal complexation, oxidation/reduction reactions, precipitation/dissolution of minerals, and surface absorption. Prerequisite: Civil and Environmental Engineering 120L or Environment 160 or equivalent. Instructor: Hsu-Kim. 3 units. C-L: Environment 242

243. Physicochemical Unit Operations in Water Treatment. Fundamental bases for design of water and waste treatment systems, including transport, mixing, sedimentation and filtration, gas transfer, coagulation, and absorption processes. Emphasis on physical and chemical treatment combinations for drinking water supply. Prerequisite: Civil Engineering 124L. Instructor: Kabala. 3 units.

244. Biological Processes in Environmental Engineering. Biological processes as they relate to environmental systems, including wastewater treatment and bioremediation. Concepts of microbiology, chemical engineering, stoichiometry, and kinetics of complex microbial metabolism, and process analyses. Specific processes discussed include carbon oxidation, nitrification/denitrification, phosphorus removal, methane production, and fermentation. Consent of instructor required. Instructor: Staff. 3 units.

245. Pollutant Transport Systems. Distribution of pollutants in natural waters and the atmosphere; diffusive and advective transport phenomena within the natural environment and through artificial conduits and storage/treatment systems. Analytical and numerical prediction methods. Prerequisites: Civil Engineering 122L and Mathematics 111 or equivalents. Instructor: Medina. 3 units.

246. Water Supply Engineering Design. The study of water resources and municipal water requirements including reservoirs, transmission, treatment and distribution systems; methods of collection, treatment, and disposal of municipal and
industrial wastewaters. The course includes the preparation of a comprehensive engineering report encompassing all aspects of municipal water and wastewater systems. Field trips to be arranged. Prerequisite: Civil Engineering 124L or consent of instructor. Instructor: Staff. 3 units.

247. Air Pollution Control Engineering. The problems of air pollution with reference to public health and environmental effects. Measurement and meteorology. Air pollution control engineering: mechanical, chemical, and biological processes and technologies. Instructor: Peirce. 3 units.

248. Solid Waste Engineering. Engineering design of material and energy recovery systems including traditional and advanced technologies. Sanitary landfills and incineration of solid wastes. Application of systems analysis to collection of municipal refuse. Major design project in solid waste management. Prerequisite: Civil Engineering 124L or consent of instructor. Instructor: Staff. 3 units. C-L: Environment 248


250. Environmental Microbiology. Fundamentals of microbiology and biochemistry as they apply to environmental engineering. General topics include cell chemistry, microbial metabolism, bioenergetics, microbial ecology and pollutant biodegradation. Prerequisites: CE124L or graduate standing or consent of the instructor. Instructor: Guncs. 3 units.

251. Engineering Analysis and Computational Mechanics. Mathematical formulation and numerical analysis of engineering systems with emphasis on applied mechanics. Equilibrium and eigenvalue problems of discrete and distributed systems; properties of these problems and discretization of distributed systems in continua by the trial functions with undetermined parameters. The use of weighted residual methods, finite elements, and finite differences. Prerequisite: senior or graduate standing. Instructor: Dolbow and Laursen. 3 units.

252. Buckling of Engineering Structures. An introduction to the underlying concepts of elastic stability and buckling, development of differential equation and energy approaches, buckling of common engineering components including link models, struts, frames, plates, and shells. Consideration will also be given to inelastic behavior, postbuckling, and design implications. Prerequisite: Civil Engineering 131L or consent of instructor. Instructor: Virgin. 3 units. C-L: Mechanical Engineering and Materials Science 252

254. Introduction to the Finite Element Method. Investigation of the finite element method as a numerical technique for solving linear ordinary and partial differential equations, using rod and beam theory, heat conduction, elastostatics and dynamics, and advective/diffusive transport as sample systems. Emphasis placed on formulation and programming of finite element models, along with critical evaluation of results. Topics include: Galerkin and weighted residual approaches, virtual work principles, discretization, element design and evaluation, mixed formulations, and transient analysis. prerequisites: a working knowledge of ordinary and partial differential equations, numerical methods, and programming in FORTRAN or MATLAB. Instructor: Dolbow and Laursen. 3 units. C-L: Mechanical Engineering and Materials Science 254

255. Nonlinear Finite Element Analysis. Formulation and solution of nonlinear initial/boundary value problems using the finite element method. Systems include nonlinear heat conduction/diffusion, geometrically nonlinear solid and structural mechanics applications, and materially nonlinear systems (for example, elastoplasticity). Emphasis on development of variational principles for nonlinear problems, finite element discretization, and equation-solving strategies for discrete nonlinear equation systems. Topics include: Newton-Raphson techniques, quasi-Newton iteration schemes, solution of nonlinear transient problems, and treatment of constraints in a nonlinear framework. An independent project, proposed by the student, is required. Prerequisite: CE/ME 254 or consent of instructor. Instructor: Laursen. 3 units. C-L: Mechanical Engineering and Materials Science 255

256. Computational Methods for Evolving Discontinuities. Presents an overview of advanced numerical methods for the treatment of engineering problems such as brittle and ductile failure and solid-liquid phase transformations in pure substances. Analytical methods for arbitrary discontinuities and interfaces are reviewed, with particular attention to the derivation of jump conditions. Partition of unity and level set methods. Prerequisites: CE 254, CE 255, or instructor consent. Instructor: Dolbow. 3 units.

260. Vadose Zone Hydrology. Transport of fluids, heat, and contaminants through unsaturated porous media. Understanding the physical laws and mathematical modeling of relevant processes. Field and laboratory measurements of moisture content and matric potential. Prerequisites: Civil Engineering 122L and Mathematics 108, or consent of instructor. Instructor: Kabala. 3 units.

262. Analytical Models of Subsurface Hydrology. Reviews the method of separation of variables, surveys integral transforms, and illustrates their application to solving initial boundary value problems. Three parts include: mathematical and hydrologic fundamentals, integral transforms and their philosophy, and detailed derivation via integral transforms of some of the most commonly used models in subsurface hydrology and environmental engineering. Discussion and use of parameter estimation techniques associated with the considered models. Prerequisites: Mathematics 108 and either Civil Engineering 122L or 123L, or consent of instructor. Instructor: Kabala. 3 units.

263. Multivariable Control. 3 units. C-L: Electrical and Computer Engineering 263, Mechanical Engineering and Materials
264. Physico-Bio-Chemical Transformations. Surveys of a selection of topics related to the interaction between fluid flow (through channels or the porous media) and physical, chemical, and biochemical transformations encountered in environmental engineering. Numerous diverse phenomena, including solute transport in the vicinity of chemically reacting surfaces, reverse osmosis, sedimentation, centrifugation, ultrafiltration, rheology, microorganism population dynamics, and others will be presented in a unifying mathematical framework. Prerequisites: Civil Engineering 122L and Mathematics 108, or consent of instructor. Instructor: Kabala. 3 units.

265. Advanced Topics in Civil and Environmental Engineering. Opportunity for study of advanced subjects relating to programs within the civil and environmental engineering department tailored to fit the requirements of individuals or small groups. Instructor: Staff. Variable credit.

269. Fundamentals and Applications of UV Processes in Environmental Systems. Ultraviolet light based processes as they relate to treatment of contaminants in water and air. Concepts in photochemistry and photobiology, fluence determination, UV disinfection, photodegradation processes for chemical contaminants, advanced oxidation processes, mathematical modeling and design of UV systems. Includes laboratory exercises. Prerequisites: CE 241 or consent or instructor. Instructor: Staff. 3 units.

270. Environmental and Engineering Geophysics. Use of geophysical methods for solving engineering and environmental problems. Theoretical frameworks, techniques, and relevant case histories as applied to engineering and environmental problems (including groundwater evaluation and protection, siting of landfills, chemical waste disposals, roads assessments, foundations investigations for structures, liquefaction and earthquake risk assessment). Introduction to theory of elasticity and wave propagation in elastic and poroelastic media, electrical and electromagnetic methods, and ground penetrating radar technology. Prerequisite: Mathematics 108 or Physics 52L or consent of instructor. Instructor: Boadu. 3 units.


272. Wave Propagation in Elastic and Poroelastic Media. Basic theory, methods of solution, and applications involving wave propagation in elastic and poroelastic media. Analytical and numerical solution of corresponding equations of motion. Linear elasticity and viscoelasticity as applied to porous media. Effective medium, soil/rock materials as composite materials. Gassmann's equations and Biot's theory for poroelastic media. Stiffness and damping characteristics of poroelastic materials. Review of engineering applications that include NDT, geotechnical and geophysical case histories. Prerequisite: Mathematics 108 or consent of instructor. Instructor: Boadu. 3 units.

273. Introduction to the Physical Principles of Remote Sensing of the Environment. The course provides an overview of the radiative transfer principles used in remote-sensing across the electromagnetic spectrum using both passive and active sensors. Special focus is placed on the process that leads from theory to the development of retrieval algorithms for satellite-based sensors, including post-processing of raw observations and uncertainty analysis. Students carry on three hands-on projects (Visible and Thermal Infrared, Active Microwave, and Passive Microwave). Background in at least one of the following disciplines is desirable: radiation transfer, signal processing, and environmental physics (Hydrology, Geology, Geophysics, Plant Biophysics, Soil Physics). Instructor consent required. Instructor: Staff. 3 units.

278. Experimental Systems. Formulation of experiments; Pi theorem and principles of similitude; data acquisition systems; static and dynamic measurement of displacement, force, and strain; interfacing experiments with digital computers for data storage, analysis, and plotting. Students select, design, perform, and interpret laboratory-scale experiments involving structures and basic material behavior. Prerequisite: senior or graduate standing in engineering or the physical sciences. Instructor: Gavin. 3 units.

273. Structural Dynamics. Formulation of dynamic models for discrete and continuous structures; normal mode analysis, deterministic and stochastic responses to shocks and environmental loading (earthquakes, winds, and waves); introduction to nonlinear dynamic systems, analysis and stability of structural components (beams and cables and large systems such as offshore towers, moored ships, and floating platforms). Instructor: Gavin. 3 units.

285. Linear System Theory. Construction of continuous and discrete-time state space models for engineering systems, and linearization of nonlinear models. Applications of linear operator theory to system analysis. Dynamics of continuous and discrete-time linear state space systems, including time-varying systems. Lyapunov stability theory. Realization theory, including notion of controllability and observability, canonical forms, minimal realizations, and balanced realizations. Design of linear feedback controllers and dynamic observers, featuring both pole placement and linear quadratic techniques. Introduction to stochastic control and filtering. Prerequisites: EE141 or ME 125 or consent of instructor. Instructor Scruggs. 3 units.

Continuous-time nonlinear and nonstationary stochastic processes, and the Fokker-Plank equations. Failure analysis and first-passage reliability analysis for continuous-time dynamic systems. Introduction to approximate analysis of nonlinear stochastic systems. Prerequisites: STAT 113 and CE 285 Instructor: Scruggs. 3 units.

**292. Structural Engineering Project Management.** Apply project management tools and skills to a structural engineering design project. Implement changes in schedule, budget, and changing client and/or regulatory climate. Work with a design team of undergraduate students. Prerequisites: not open to students who have had CE 192, CE 193, or CE 293. Consent of instructor required. Instructor: Nadeau. 3 units.

**293. Environmental Engineering Project Management.** Apply project management tools and skills to an environmental engineering design project. Implement changes in schedule, budget, and changing client and/or regulatory climate. Work with a design team of undergraduate students. Consent of instructor required. Prerequisites: not open to students who have had CE 192, CE 193, CE 292. Instructor: Schaad. 3 units.

**301. Graduate Colloquium.** Current topics in civil and environmental engineering theory and practice. Weekly seminar series. Instructor: Hueckel. 0 units.


**309. Internship.** Student gains practical experience in civil and environmental engineering by taking a job in industry, and writes a report about this experience. Requires prior consent from the student's advisor and from the director of graduate studies. Instructor: Staff. 1 unit.

**399. Special Readings in Civil and Environmental Engineering.** Special individual readings in a specific area of study in civil and environmental engineering. Approval of director of graduate studies required. 1 to 3 units. Instructor: Graduate faculty. Variable credit.

**Electrical and Computer Engineering**

Professor Collins, *Chair; Associate Professor Board, Associate Chair; Professor Cummer, Director of Graduate Studies* (3455 CIEMAS); Professors Brady, Brown, Carin, Chakrabarty, Fair, Glass, Joines, Jokerst, Katsouleas, Krolik, Liu, Massoud, Nolte, Smith, Trivedi; Associate Professors Board, Brooke, Cummer, Kedem, Nowacek, Sorin, Teitsworth; Assistant Professors Dwyer, George, Lebeck, Kim, Reynolds, Roy Choudhury, Stiff-Roberts, Willett, Yoshie; Professors Emeriti Casey, Marinos, Owen, Wang and Wilson; Professor of the Practice Ybarra; Associate Professor of the Practice Huettel; Assistant Professor of the Practice Gustafson; Assistant Research Professors Degiron, Liao, Morizio, Remus, Tantum, Wolter; Adjunct Professors Derby and Lampert; Adjunct Associate Professor Janet, Ozev, Pitsianis, Vu; Visiting Professors Kaiser and McCumber

Graduate study in the Department of Electrical and Computer Engineering (ECE) is intended to prepare students for leadership roles in academia, industry, and government that require creative technical problem solving skills. The department offers both PhD and MS degree programs with options for study in a broad spectrum of areas within electrical and computer engineering. Research and course offerings in the department are organized into five areas of specialization: computer engineering, sensing and waves, micro/nano systems, photonics, and signal processing and communications. Detailed descriptions of course offerings, faculty research interests, and degree requirements may be found on the department's Web Site, [http://www.ece.duke.edu/](http://www.ece.duke.edu/). Interdisciplinary programs are also available that connect the above areas with those in other engineering departments, computer science, the natural sciences, and the Medical School. Students in the department may also be involved in research conducted in one of Duke's Centers (e.g. the Fitzpatrick Institute for Photonics and Communications). Recommended prerequisites for graduate study in electrical engineering include knowledge of basic mathematics, statistics, and physics, electrical networks, electromagnetics, and system theory. Students with non-electrical and/or computer engineering undergraduate degrees are welcome to apply but should discuss their enrollment and course requirement options with the Director of Graduate Studies. The MS degree program includes thesis, project, or courses-only options. A qualifying examination is required for the PhD degree program and must be taken by the beginning of the third semester of enrollment. The exam is intended to assess the student's potential for success as a researcher in their chosen sub-discipline. To ensure breadth of study, PhD students are required to take at least three courses in two areas outside their area of specialization. There is no foreign language requirement.

**Electrical and Computer Engineering (ECE)**

**211. Quantum Mechanics.** Discussion of wave mechanics including elementary applications, free particle dynamics, Schrödinger equation including treatment of systems with exact solutions, and approximate methods for time-dependent quantum mechanical systems with emphasis on quantum phenomena underlying solid-state electronics and physics. Prerequisite: Mathematics 107 or equivalent. Instructor: Brady, Brown, or Stiff-Roberts. 3 units.

**212. Introduction to Micro-Electromechanical Systems (MEMS).** Design, simulation, fabrication, and characterization of micro-electromechanical systems (MEMS) devices. Integration of non-conventional devices into functional systems. Principles of fabrication, mechanics in micrometer scale, transducers and actuators, and issues in system design and integration. Topics presented in the context of example systems. Lab covers design, simulation, and realization of MEMS
devices using commercially available foundry process. Prerequisite: ECE 51L or ME 125L or equivalent. Instructor: Kim. 3 units.

214. Introduction to Solid-State Physics. Discussion of solid-state phenomena including crystalline structures, X-ray and particle diffraction in crystals, lattice dynamics, free electron theory of metals, energy bands, and superconductivity, with emphasis on understanding electrical and optical properties of solids. Prerequisite: quantum physics at the level of Physics 143L or Electrical and Computer Engineering 211. Instructor: Teitsworth. 3 units.

215. Semiconductor Physics. A quantitative treatment of the physical processes that underlie semiconductor device operation. Topics include band theory and conduction phenomena; equilibrium and nonequilibrium charge carrier distributions; charge generation, injection, and recombination; drift and diffusion processes. Prerequisite: Electrical and Computer Engineering 211 or consent of instructor. Instructor: Staff. 3 units.


217. Analog Integrated Circuits. Analysis and design of bipolar and CMOS analog integrated circuits. SPICE device models and circuit macromodels. Classical operational amplifier structures, current feedback amplifiers, and building blocks for analog signal processing, including operational transconductance amplifiers and current conveyors. Biasing issues, gain and bandwidth, compensation, and noise. Influence of technology and device structure on circuit performance. Extensive use of industry-standard CAD tools, such as Analog Workbench. Prerequisite: Electrical Engineering 216. Instructor: Richards. 3 units.

218. Integrated Circuit Engineering. Basic processing techniques and layout technology for integrated circuits. Photolithography, diffusion, oxidation, ion implantation, and metallization. Design, fabrication, and testing of integrated circuits. Prerequisite: Electrical and Computer Engineering 162 or 163L. Instructor: Fair. 3 units.


225. Nanophotonics. Theory and applications of nanophotonics and sub-wavelength optics. Photonic crystals, near-field optics, surface-plasmon optics, microcavities, and nanoscale light emitters. Prerequisite: Electrical and Computer Engineering 53L or equivalent. Instructor: Yoshie. 3 units.

226. Optoelectronic Devices. Devices for conversion of electrons to photons and photons to electrons. Optical processes in semiconductors: absorption, spontaneous emission and stimulated emission. Light-emitting diodes (LEDs), semiconductor lasers, quantum-well emitters, photodetectors, modulators and optical fiber networks. Prerequisite: Electrical and Computer Engineering 216 or equivalent. Instructor: Stiff-Roberts. 3 units.

277. Quantum Information Science. Fundamental concepts and progress in quantum information science. Quantum circuits, quantum universality theorem, quantum algorithms, quantum operations and quantum error correction codes, fault-tolerant architectures, security in quantum communications, quantum key distribution, physical systems for realizing quantum logic, quantum repeaters and long-distance quantum communication. Prerequisites: ECE 211 or Physics 211 or equivalent. Instructor: Kim. 3 units. C-L: Physics 272

241. Linear System Theory and Optimal Control. Consideration of system theory fundamentals; observability, controllability, and realizability; stability analysis; linear feedback, linear quadratic regulators, Riccati equation, and trajectory tracking. Prerequisite: Electrical and Computer Engineering 141. Instructor: P. Wang. 3 units.

243. Pattern Classification and Recognition Technology. Theory and practice of recognition technology: pattern classification, pattern recognition, automatic computer decision-making algorithms. Applications covered include medical diseases, severe weather, industrial parts, biometrics, bioinformation, animal behavior patterns, image processing, and human visual systems. Perception as an integral component of intelligent systems. This course prepares students for advanced study of data fusion, data mining, knowledge base construction, problem-solving methodologies of "intelligent agents" and the design of intelligent control systems. Prerequisites: Mathematics 107, Statistics 113 or Mathematics 135, Computer Science 6, or consent of instructor. Instructor: Collins or P. Wang. 3 units.

245. Digital Control Systems. Review of traditional techniques used for the design of discrete-time control systems; introduction of "nonclassical" control problems of intelligent machines such as robots. Limitations of the assumptions required by traditional design and analysis tools used in automatic control. Consent of instructor required. Instructor: Staff. 3 units.

246. Optimal Control. Review of basic linear control theory and linear/nonlinear programming. Dynamic programming and the Hamilton-Jacobi-Bellman Equation. Calculus of variations. Hamiltonian and costate equations. Pontryagin's Minimum Principle. Solution to common constrained optimization problems. This course is designed to satisfy the need of several
251. Advanced Digital System Design. This course covers the fundamentals of advanced digital system design, and the use of a hardware description language, VHDL, for their synthesis and simulation. Examples of systems considered include the arithmetic/logic unit, memory, and microcontrollers. The course includes an appropriate capstone design project that incorporates engineering standards and realistic constraints in the outcome of the design process. Additionally, the designer must consider most of the following: Cost, environmental impact, manufacturability, health and safety, ethics, social and political impact. Each design project is executed by a team of 4 or 5 students who are responsible for generating a final written project report and making an appropriate presentation of their results to the class. Prerequisite: Electrical and Computer Engineering 52L and Senior/graduate student standing. Instructor: Derby. 3 units.

252. Advanced Computer Architecture I. 3 units. C-L: see Computer Science 220


254. Fault-Tolerant and Testable Computer Systems. Technological reasons for faults, fault models, information redundancy, spatial redundancy, backward and forward error recovery, fault-tolerant hardware and software, modeling and analysis, testing, and design for test. Prerequisite: Electrical and Computer Engineering 152 or equivalent. Instructor: Sorin. 3 units. C-L: Computer Science 225

255. Probability for Electrical and Computer Engineers. Basic concepts and techniques used stochastic modeling of systems with applications to performance and reliability of computer and communications systems. Elements of probability, random variables (discrete and continuous), expectation, conditional distributions, stochastic processes, discrete and continuous time Markov chains, introduction to queuing systems and networks. Prerequisite: Mathematics 107. Instructor: Trivedi. 3 units. C-L: Computer Science 226


259. Advanced Computer Architecture II. 3 units. C-L: see Computer Science 221

261. CMOS VLSI Design Methodologies. Emphasis on full-custom chip design. Extensive use of CAD tools for IC design, simulation, and layout verification. Techniques for designing high-speed, low-power, and easily-testable circuits. Semester design project: Groups of four students design and simulate a simple custom IC using Mentor Graphics CAD tools. Teams and project scope are multidisciplinary; each team includes students with interests in several of the following areas: analog design, digital design, computer science, computer engineering, signal processing, biomedical engineering, electronics, photonics. A formal project proposal, a written project report, and a formal project presentation are also required. The chip design incorporates considerations such as cost, economic viability, environmental impact, ethical issues, manufacturability, and social and political impact. Prerequisites: Electrical and Computer Engineering 52L and Electrical and Computer Engineering 163L. Some background in computer organization is helpful but not required. Instructor: Chakrabarty. 3 units.


263. Multivariable Control. 3 units. C-L: Civil Engineering 263, Mechanical Engineering and Materials Science 263

264. CAD For Mixed-Signal Circuits. The course focuses on various aspects of design automation for mixed-signal circuits.
Circuit simulation methods including graph-based circuit representation, automated derivation and solving of nodal equations, and DC analysis, test automation approaches including test equipments, test generation, fault simulation, and built-in-self-test, and automated circuit synthesis including architecture generation, circuit synthesis, task generation, placement and routing are the major topics. The course will have one major project, 4-6 homework assignments, one midterm, and one final. Prerequisites: ECE 163L. Permission of instructor required. Instructor: Staff. 3 units.

266. Synthesis and Verification of VLSI Systems. Algorithms and CAD tools for VLSI synthesis and design verification, logic synthesis, multi-level logic optimization, high-level synthesis, logic simulation, timing analysis, formal verification. Prerequisite: Electrical and Computer Engineering 52L or equivalent. Instructor: Chakrabarty. 3 units.

267. Radiofrequency (RF) Transceiver Design. Design of wireless radiofrequency transceivers. Analog and digital modulation, digital modulation schemes, system level design for receiver and transmitter path, wireless communication standards and determining system parameters for standard compliance, fundamentals of synthesizer design, and circuit level design of low-noise amplifiers and mixers. Prerequisites: Electrical and Computer Engineering 54L and Electrical and Computer Engineering 163L or equivalent. Instructor: Staff. 3 units.

269. VLSI System Testing. Fault modeling, fault simulation, test generation algorithms, testability measures, design for testability, scan design, built-in self-test, system-on-a-chip testing, memory testing. Prerequisite: Electrical and Computer Engineering 52L or equivalent. Instructor: Chakrabarty. 3 units.

271. Electromagnetic Theory. The classical theory of Maxwell's equations; electrostatics, magnetostatics, boundary value problems including numerical solutions, currents and their interactions, and force and energy relations. Three class sessions. Prerequisite: Electrical and Computer Engineering 53L. Instructor: Carin, Joines, Liu, or Smith. 3 units.


273. Optical Communication Systems. Mathematical methods, physical ideas, and device concepts of optoelectronics. Maxwell's equations, and definitions of energy density and power flow. Transmission and reflection of plane waves at interfaces. Optical resonators, waveguides, fibers, and detectors are also presented. Prerequisite: Electrical and Computer Engineering 53L or equivalent. Instructor: Carin or Liu. 3 units.


277. Computational Electromagnetics. Systematic discussion of useful numerical methods in computational electromagnetics including integral equation techniques and differential equation techniques, both in the frequency and time domains. Hands-on experience with numerical techniques, including the method of moments, finite element and finite-difference time-domain methods, and modern high order and spectral domain methods. Prerequisite: Electrical and Computer Engineering 271 or consent of instructor. Instructor: Carin or Liu. 3 units.

278. Inverse Problems in Electromagnetics and Acoustics. Systematic discussion of practical inverse problems in electromagnetics and acoustics. Hands-on experience with numerical solution of inverse problems, both linear and nonlinear in nature. Comprehensive study includes: discrete linear and nonlinear inverse methods, origin and solution of nonuniqueness, tomography, wave-equation based linear inverse methods, and nonlinear inverse scattering methods. Assignments are project oriented using MATLAB. Prerequisites: Graduate level acoustics or electromagnetics (Electrical and Computer Engineering 271), or consent of instructor. Instructor: Carin or Liu. 3 units.

279. Waves in Matter. Analysis of wave phenomena that occur in materials based on fundamental formulations for electromagnetic and elastic waves. Examples from these and other classes of waves are used to demonstrate general wave phenomena such as dispersion, anisotropy, and causality; phase, group, and energy propagation velocities and directions; propagation and excitation of surface waves; propagation in inhomogeneous media; and nonlinearity and instability. Applications that exploit these wave phenomena in general sensing applications are explored. Prerequisites: Electrical and Computer Engineering 53L. Instructor: Cummer. 3 units.


282. Digital Signal Processing. Introduction to fundamental algorithms used to process digital signals. Basic discrete time system theory, the discrete Fourier transform, the FFT algorithm, linear filtering using the FFT, linear production and the Wiener filter, adaptive filters and applications, the LMS algorithm and its convergence, recursive least-squares filters, nonparametric and parametric power spectrum estimation minimum variance and eigenanalysis algorithms for spectrum estimation. Prerequisite: Electrical and Computer Engineering 281 or equivalent with consent of the instructor. Instructor:
Collins, Krolik, Nolte, Tantum, or Willett. One course. 3 units.


284. Acoustics and Hearing (GE, IM). 3 units. C-L: see Biomedical Engineering 235

285. Signal Detection and Extraction Theory. Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory. Prerequisite: Electrical and Computer Engineering 281 or consent of instructor. Instructor: Nolte. 3 units.

286. Digital Processing of Speech Signals. Detailed treatment of the theory and application of digital speech processing. Modeling of the speech production system and speech signals; speech processing methods; digital techniques applied in speech transmission, speech synthesis, speech recognition, and speaker verification. Acoustic-phonetics, digital speech modeling techniques, LPC analysis methods, speech coding techniques. Application case studies: synthesis, vocoders, DTW (dynamic time warping)/HMM (hidden Markov modeling) recognition methods, speaker verification/identification. Prerequisite: Electrical and Computer Engineering 182 or equivalent or consent of instructor. Instructor: Staff. 3 units.

288. Sensor Array Signal Processing. An in-depth treatment of the fundamental concepts, theory, and practice of sensor array processing of signals carried by propagating waves. Topics include: multidimensional frequency-domain representations of space-time signals and linear systems; apertures and sampling of space-time signals; beamforming and filtering in the space-time and frequency domains, discrete random fields; adaptive beamforming methods; high resolution spatial spectral estimation; optimal detection, estimation, and performance bounds for sensor arrays; wave propagation models used in sensor array processing; blind beamforming and source separation methods; multiple-input-multiple-output (MIMO) array processing; application examples from radar, sonar, and communications systems. Instructor: Staff. 3 units.


299. Advanced Topics in Electrical and Computer Engineering. Opportunity for study of advanced subjects related to programs within the electrical and computer engineering department tailored to fit the requirements of a small group. Instructor: Staff. 3 units.

For Graduate Students Only

310. Foundations of Nanoscale Science and Technology. This course is the introductory course for the Graduate Certificate Program in Nanoscience (GPNANO) and is designed to introduce students to the interdisciplinary aspects of nanoscience by integrating important components of the broad research field together. This integrated approach will cross the traditional disciplines of biology, chemistry, electrical & computer engineering, computer science, and physics. Fundamental properties of materials at the nanoscale, synthesis of nanoparticles, characterization tools, and self-assembly. Prerequisites: Physics 62L and Chem 21L or instructor approval. C-L: NANO 200 pending in COMPSCI, CHEM, and PHYS. Instructor: Dwyer. 3 units. C-L: Nanosciences 310

316. Advanced Physics of Semiconductor Devices. Semiconductor materials: band structure and carrier statistics. Advanced treatments of metal-semiconductor contacts, Schottky barriers, p-n junctions, bipolar transistors (charge-control and Gummel-Poon models), and field-effect transistors (short channel effects, scaling theory, subthreshold conduction, nonuniformly doped substrates, surface and buried-channel devices, hot-electron effects). Device modeling in two dimensions using PISCES. Prerequisite: Electrical Engineering 216. Instructor: Massoud. 3 units.

318. Integrated Circuit Fabrication Laboratory. Introduction to IC fabrication processes. Device layout. Mask design and technology. Wafer cleaning, etching, thermal oxidation, thermal diffusion, lithography, and metallization. Laboratory fabrication and characterization of basic IC elements (p-n junctions, resistors, MOS capacitors, gated diodes, and MOSFETs). Use of four-point probe, ellipsometer, spreading resistance probe, scanning electron microscope, and evaporation system. Testing of basic inverters and gates. Prerequisite: Electrical Engineering 218 and consent of instructor. Instructor: Massoud. 3 units.

322. Quantum Electronics. Quantum theory of light-matter interaction. Laser physics (electron oscillator model, rate equations, gain, lasing condition, oscillation dynamics, modulation) and nonlinear optics (electro-optic effect, second harmonic generation, phase matching, optical parametric oscillation and amplification, third-order nonlinearity, optical bistability.) Prerequisite ECE 211, Physics 211, or equivalent. Instructors: Stiff-Roberts or Yoshie. One course. 3 units.

352. Advanced Topics in Digital Systems. A selection of advanced topics from the areas of digital computer architectures
and fault-tolerant computer design. Prerequisite: Electrical Engineering 252 or equivalent. Instructor: Staff. 3 units. C-L: Computer Science 320

361. Advanced VLSI Design. 3 units. C-L: see Computer Science 322

371. Advanced Electromagnetic Theory. Instructor: Staff. 3 units.

373. Selected Topics in Field Theory. Instructor: Staff. 3 units.


376. Lens Design. Paraxial and computational ray tracing. Merit functions. Wave and chromatic aberrations. Lenses in photography, microscopy and telescope. Spectrograph design. Emerging trends in lens system design, including multiple aperture and catadioptric designs and nonimaging design for solar energy collection. Design project management. Each student must propose and complete a design study, including a written project report and a formal design review. Prerequisite: Electrical and Computer Engineering 122 or 274. Instructor: Brady. 3 units. 3 units.

391. Internship. Student gains practical electrical and computer engineering experience by taking a job in industry, and writing a report about this experience. Requires prior consent from the student's advisor and from the director of graduate studies. May be repeated with consent of the advisor and the director of graduate studies. Credit/no credit grading only. Instructor: Staff. 1 unit.

399. Special Readings in Electrical Engineering. Special individual readings in a specified area of study in electrical engineering. Approval of director of graduate studies required. 1 to 4 units. Instructor: Graduate staff. Variable credit.

Mechanical Engineering and Materials Science

Professor Laursen, Chair (142A Engineering); Research Scientist Kielb, Associate Chair; Associate Professor Zauscher, Director of Graduate Studies (3385 Ciemas); Professors Bejan, Cocks, Dowell, Garg, Hall, Marszalek, Needham, Shaughnessy, Tan; Associate Professors Bliss, Curtarolo, Ferrari, Franzoni, Howle, Knight, Zhong; Assistant Professors Chen, Hotz, Lazarides, Mann, Protz, Zhao; Assistant Research Professor Thomas; Senior Research Scientists Kielb; Adjunct Assistant Professor Stepp; Professors Emeriti Harman, Pearsall, and Hochmuth

The department offers programs of study and research leading to the MS and PhD degrees in both mechanical engineering and materials science. The department’s broad areas of concentration include nonlinear dynamics and control, unsteady aerodynamics and fluid mechanics including aeroelasticity (fluid/structure interaction), biomaterials and biomechanics, and thermal sciences and engineering. Additional areas of concentration include atomic force microscopy, biomaterials, electronic materials, material characteristics/properties and thin films.

The department emphasizes a highly research-oriented PhD degree program. Students in the PhD degree program who do not already have a master’s degree are urged to meet the course and other general requirements of this degree and to obtain it during completion of their program. Programs of study are highly flexible to meet individual needs.

Current research areas include: aeroelasticity; atomic force microscopy; bearing design and lubrication; biorheology; cell, membrane, and surface engineering; chaotic systems; computational fluid dynamics; computational materials science; convection; diffusion and kinetics on Si, GaAs, and other electronic materials; feedback and feed-forward control systems; fluid dynamics of biological systems; heat transfer in heterogeneous media; magnetic bearings; mechanical properties of kidney stones; nano-tribology; nonlinear dynamics; oxide heterostructures; robotics; shock-wave lithotripsy; sound propagation and absorbing materials; thermal design by entropy generation minimization; turbomachinery; ultrasound contrast enhancement; unsteady aerodynamics; and vibrations and acoustics of dynamic systems.

For additional information, visit the departmental Web site at: http://www.mems.duke.edu.

Mechanical Engineering and Materials Science Courses (ME)


204. Plates and Shells. 3 units. C-L: see Civil Engineering 204

207. Transport Phenomena in Biological Systems (AC or GE, BB). 3 units. C-L: see Biomedical Engineering 207; also C-L: Civil Engineering 207

209. Soft Wet Materials and Interfaces. The materials science and engineering of soft wet materials and interfaces. Emphasis on the relationships between composition, structure, properties and performance of macromolecules, self assembling colloidal systems, linear polymers and hydrogels in aqueous and nonaqueous liquid media, including the role of water as an “organizing” solvent. Applications of these materials in biotechnology, medical technology, microelectronic technology, and nature's own

211. Theoretical and Applied Polymer Science (GE, BB). An intermediate course in soft condensed matter physics dealing with the structure and properties of polymers and biopolymers. Introduction to polymer syntheses based on chemical reaction kinetics, polymer characterization. Emphasizes (bio)polymers on surfaces and interfaces in aqueous environments, interactions of (bio)polymer surfaces, including wetting and adhesion phenomena. Instructor: Zauscher. 3 units. C-L: Biomedical Engineering 208

212. Electronic Materials. An advanced course in materials science and engineering dealing with materials important for solid-state electronics and the various semiconductors. Emphasis on thermodynamic concepts and on defects in these materials. Materials preparation and modification methods for technological defects in these materials. Prerequisite: Mechanical Engineering 83L. Instructor: Curtarol or Tan. 3 units.

213. Physical Metallurgy. An advanced materials science course focusing on the relationships between structure and properties in metals and alloys. Conceptual and mathematical models developed and analyzed for crystal structures, elastic and plastic deformation, phase transformations, thermodynamic behavior, and electrical and magnetic properties. Prerequisites: Mechanical Engineering 83L and 101L. Instructor: Staff. 3 units.

214. Biomedical Materials and Artificial Organs (GE, BB). 3 units. C-L: see Biomedical Engineering 215

215. Biomedical Materials and Artificial Organs. An advanced materials science course dealing with the response of materials to applied forces. Mechanical fundamentals; stress-strain relationships for elastic behavior; theory of plasticity. Metallurgical fundamentals; plastic deformation, dislocation theory; strengthening mechanisms. Mechanical behavior of polymers. Applications to materials testing. Prerequisites: Engineering 75L and Mechanical Engineering 83L. Instructor: Staff. 3 units.


217. Thermodynamics of Electronic Materials. Basic thermodynamic concepts applied to solid state materials with emphasis on thermodynamically relevant electronic materials such as silicon and GaAs. Thermodynamic functions, phase diagrams, solubilities and thermal equilibrium concentrations of point defects; nonequilibrium processes and the kinetic phenomena of diffusion, precipitation, and growth. Instructor: Tan. 3 units.

218. Compressible Fluid Flow. Basic concepts of the flow of gases from the subsonic to the hypersonic regime. One-dimensional wave motion, the acoustic equations, and waves of finite amplitude. Effects of area change, friction, heat transfer, and shock on one-dimensional flow. Moving and oblique shock waves and Prandtl-Meyer expansion. Prerequisite: ME126 or equivalent. Instructor: Shaughnessy. 3 units.

219. Mechanics of Viscous Fluids. Equations of motion for a viscous fluid, constitutive equations for momentum and energy transfer obtained from second-law considerations, general properties and exact solutions of the Navier-Stokes and Stokes (creeping-flow) equations, applications to problems of blood flow in large and small vessels. Prerequisite: ME126 or equivalent. Instructor: Staff. 3 units.

220. Intermediate Fluid Mechanics. A survey of the principal concepts and equations of fluid mechanics, fluid statics, surface tension, the Eulerian and Lagrangian description, kinematics, Reynolds transport theorem, the differential and integral equations of motion, constitutive equations for a Newtonian fluid, the Navier-Stokes equations, and boundary conditions on velocity and stress at material interfaces. Instructor: Shaughnessy. 3 units.


222. Lubrication. Derivation and application of the basic governing equations for lubrication; the Reynolds equation and energy equation for thin films. Analytical and computational solutions to the governing equations. Analysis and design of hydrostatic and hydrodynamic slider bearings and journal bearings. Introduction to the effects of fluid inertia and compressibility. Dynamic characteristics of a fluid film and effects of bearing design on dynamics of machinery. Prerequisites: Mathematics 108 and Mechanical Engineering 126L. Instructor: Knight. 3 units.

223. Computational Fluid Mechanics and Heat Transfer. An exposition of numerical techniques commonly used for the solution of partial differential equations encountered in engineering physics. Finite-difference schemes (which are well-suited for fluid mechanics problems); notions of accuracy, conservation, consistency, stability, and convergence. Recent applications of weighted residuals methods (Galerkin), finite-element methods, and grid generation techniques. Through specific examples, the student is guided to construct and assess the performance of the numerical scheme selected for the particular
type of transport equation (parabolic, elliptic, or hyperbolic). Instructor: Howle. 3 units.


231. Adaptive Structures: Dynamics and Control. Integration of structural dynamics, linear systems theory, signal processing, transduction device dynamics, and control theory for modeling and design of adaptive structures. Classical and modern control approaches applied to reverberant plants. Fundamentals of adaptive feedforward control and its integration with feedback control. Presentation of a methodical design approach to adaptive systems and structures with emphasis on the physics of the system. Numerous MATLAB examples provided with course material as well as classroom and laboratory demonstrations. Instructor: Staff. 3 units.

232. Optimal Control. 3 units. C-L: see Electrical and Computer Engineering 246

233. Intelligent Systems. An introductory course on learning and intelligent-systems techniques for the modeling and control of dynamical systems. Review of theoretical foundations in dynamical systems, and in static and dynamic optimization. Numerical methods and paradigms that exploit learning and optimization in order to deal with complexity, nonlinearity, and uncertainty. Investigation of theory and algorithms for neural networks, graphical models, and genetic algorithms. Interdisciplinary applications and demonstrations drawn from engineering and computer science, including but not limited to adaptive control, estimation, robot motion and sensor planning. Prerequisites: Mathematics 107 or 111. Consent of instructor required. Instructor: Ferrari. 3 units.

234. Energy Flow and Wave Propagation in Elastic Solids. Derivation of equations for wave motion in simple structural shapes: strings, longitudinal rods, beams and membranes, plates and shells. Solution techniques, analysis of systems behavior. Topics covered include: nondispersive and dispersive waves, multiple wave types (dilational, distortion), group velocity, impedance concepts including driving point impedances and moment impedances. Power and energy for different cases of wave propagation. Prerequisites: Engineering 123L and Mathematics 108 or consent of instructor. Instructor: Franzoni. 3 units. C-L: Civil Engineering 211

235. Advanced Mechanical Vibrations. Advanced mechanical vibrations are studied primarily with emphasis on application of analytical and computational methods to machine design and vibration control problems. Equations of motion are developed using Lagrange's equations. A single degree-of-freedom system is used to determine free vibration characteristics and response to impulse, harmonic periodic excitations, and random. The study of two and three degree-of-freedom systems includes the determination of the eigenvalues and eigenvectors, and an in-depth study of modal analysis methods. The finite element method is used to conduct basic vibration analysis of systems with a large number of degrees of freedom. The student learns how to balance rotating machines, and how to design suspension systems, isolation systems, vibration sensors, and tuned vibration absorbers. Instructor: Kielb. 3 units.

236. Engineering Acoustics. Fundamentals of acoustics including sound generation, propagation, reflection, absorption, and scattering. Emphasis on basic principles and analytical methods in the description of wave motion and the characterization of sound fields. Applications including topics from noise control, sound reproduction, architectural acoustics, and aerodynamic noise. Occasional classroom or laboratory demonstration. This course is open only to undergraduate seniors and graduate students. Prerequisites: Mathematics 108 or equivalent or consent of instructor. Instructor: Bliss. 3 units.

237. Aerodynamics. Fundamentals of aerodynamics applied to wings and bodies in subsonic and supersonic flow. Basic principles of fluid mechanics analytical methods for aerodynamic analysis. Two- and three-dimensional wing theory, slender-body theory, lifting surface methods, vortex and wave drag. Brief introduction to vehicle design, performance and dynamics. Special topics such as unsteady aerodynamics, vortex wake behavior, and propeller and rotor aerodynamics. This course is open only to undergraduate seniors and graduate students. Prerequisites: ME126 and Mathematics 108 or equivalent. Instructor: Bliss. 3 units.


239. Unsteady Aerodynamics. Analytical and numerical methods for computing the unsteady aerodynamic behavior of airfoils and wings. Small disturbance approximation to the full potential equation. Unsteady vortex dynamics. Kelvin impulse and apparent mass concepts applied to unsteady flows. Two-dimensional unsteady thin airfoil theory. Time domain and frequency domain analyses of unsteady flows. Three-dimensional unsteady wing theory. Introduction to unsteady aerodynamic behavior of turbomachinery. Prerequisite: Mechanical Engineering 237. Instructor: Hall. 3 units.

241. Electromagnetic Processes in Fluids. Electromagnetic processes and transport phenomena in fluids is overviewed. Topics to be discussed include: Maxwell's equations, statistical thermodynamic processes, origin of surface forces (i.e. Van der Waals), plasma in gases and electrolyte distribution, wave propagation near boundaries and in complex media, transport equations in continuum limit. Consent of instructor required. Instructor: Yellen. 1 unit.

252. Buckling of Engineering Structures. 3 units. C-L: see Civil Engineering 252

254. Introduction to the Finite Element Method. 3 units. C-L: see Civil Engineering 254

255. Nonlinear Finite Element Analysis. 3 units. C-L: see Civil Engineering 255

263. Multivariable Control. 3 units. C-L: Civil Engineering 263, Electrical and Computer Engineering 263

265. Advanced Topics in Mechanical Engineering. Opportunity for study of advanced subjects related to programs within mechanical engineering tailored to fit the requirements of a small group. Approval of director of undergraduate or graduate studies required. Instructor: Staff. Variable credit.

268. Cellular and Biosurface Engineering. A combination of fundamental concepts in materials science, colloids, and interfaces that form a basis for characterizing: the physical properties of biopolymers, microparticles, artificial membranes, biological membranes, and cells; and the interactions of these materials at biofluid interfaces. Definition of the subject as a coherent discipline and application of its fundamental concepts to biology, medicine, and biotechnology. Prerequisite: Mechanical Engineering 208 or consent of instructor. Instructor: Needham. 3 units.

270. Robot Control and Automation. Review of kinematics and dynamics of robotic devices; mechanical considerations in design of automated systems and processes, hydraulic and pneumatic control of components and circuits; stability analysis of robots involving nonlinearities; robotic sensors and interfacing; flexible manufacturing; man-machine interaction and safety consideration. Prerequisites: Mechanical Engineering 230 or equivalent and consent of instructor. Instructor: Staff. 3 units.

275. Product Safety and Design. An advanced engineering design course that develops approaches to assessing and improving the safety of products and product systems. Safety is presented in terms of acceptable risk and analyzed through legal case studies. Probabilistic decision making: risk economics; risk analysis and assessment. Corequisite: Mechanical Engineering 160L. Instructor: Staff. 3 units.

276. Designs and Decisions. Successful engineering entrepreneurship requires both the creation of new devices and processes and the ability to make rational selections among design alternatives. Design methodology is presented that fosters creativity and introduces TRIZ (the Russian acronym for Theory of Inventive Problem Solving). Decisions among design alternatives are structured and analyzed in graphical and probabilistic terms: tree diagrams; sampling theory; hypothesis testing; and confidence levels. Corequisite: Mechanical Engineering 160L or consent of instructor. Instructor: Staff. 3 units.


280. Convective Heat Transfer. Models and equations for fluid motion, the general energy equation, and transport properties. Exact, approximate, and boundary layer solutions for laminar flow heat transfer problems. Use of the principle of similarity and analogy in the solution of turbulent flow heat transfer. Two-phase flow, nucleation, boiling, and condensation heat and mass transfer. Instructor: Bejan. 3 units.

281. Fundamentals of Heat Conduction. Fourier heat transfer solution. Solution methods including separation of variables, transform calculus, complex variables. Green's function will be introduced to solve transient and steady-state heat conduction problems in rectangular, cylindrical, and spherical coordinates. Microscopic heat conduction mechanisms, thermophysical properties, Boltzmann transport equation. Prerequisite: Mathematics 111 or consent of instructor. Instructor: Staff. 3 units.

282. Fundamentals of Thermal Radiation. Radiative properties of materials, radiation-materials interaction and radiative energy transfer. Emphasis on fundamental concepts including energy levels and electromagnetic waves as well as analytical methods for calculating radiative properties and radiation transfer in absorbing, emitting, and scattering media. Applications cover laser-material interactions in addition to traditional areas such as combustion and thermal insulation. Prerequisite: Mathematics 108 or consent of instructor. Instructor: Staff. 3 units.

301. Biological Engineering Seminar Series (CBIMMS and CBTE). Seminar series featuring in alternate weeks invited speakers and pre-seminar discussions. Research topics in biological engineering, with emphasis on bioinspired materials and materials systems, biomolecular, and tissue engineering. Enrollment is required of all BIMMS and BTE certificate program students in their first and second year. Open to others for credit or audit. Instructor consent required. Instructors: Zauscher, Craig, and Reichert. 1 unit. C-L: Biomedical Engineering 301

302. Biological Engineering Seminar Series (CBIMMS and CBTE). Seminar series featuring in alternate weeks invited speakers and pre-seminar discussions. Research topics in biological engineering, with emphasis on bioinspired materials and materials systems, biomolecular, and tissue engineering. Enrollment is required of all BIMMS and BTE certificate program students in their first and second year. Open to others for credit or audit. Instructor consent required. Instructors: Zauscher, Craig, and Reichert. 1 unit. C-L: Biomedical Engineering 302

Laboratory. This course will give a hands-on introduction to characterization and clean room-based processing methods that play an important role in the fabrication and characterization of materials. Clean-room-based processing methods to be covered include: basic photolithography, evaporation, electron beam lithography, and wet and dry etching. Characterization methods to be covered include: atomic force microscopy, scanning electron microscopy, transmission electron microscopy, and X-ray photoelectron spectroscopy. Credit/No Credit. Permission Required. Instructor: Walters. 3 units.

325. Aeroelasticity. A study of the statics and dynamics of fluid/structural interaction. Topics covered include static aeroelasticity (divergence, control surface reversal), dynamic aeroelasticity (flutter, gust response), unsteady aerodynamics (subsonic, supersonic, and transonic flow), and a review of the recent literature including nonlinear effects such as chaotic oscillations. Prerequisite: Mathematics 230 and consent of instructor. Instructor: Dowell. 3 units.

331. Nonlinear Control Systems. Analytical, computational, and graphical techniques for solution of nonlinear systems; Krylov and Bogoliubov asymptotic method; describing function techniques for analysis and design; Liapounov functions and Lure's methods for stability analysis; Aizerman and Kalman conjectures; Popov, circle, and other frequency-domain stability criteria for analysis and synthesis. Prerequisite: Mechanical Engineering 230 or consent of instructor. Instructor: Dowell. 3 units.

335. Nonlinear Mechanical Vibration. A comprehensive treatment of the role of nonlinearities in engineering dynamics and vibration. Analytical, numerical, and experimental techniques are developed within a geometrical framework. Prerequisite: Mechanical Engineering 210 or 235 or equivalent. Instructor: Virgin. 3 units.

391. Curricular Practical Training. Curricular Practical Training. Student gains practical Mechanical Engineering and Materials Science experience by taking a job in industry and writing a report about this experience. Course requires prior consent form the student’s advisor and from the Director of Graduate Studies and may be repeated with consent of the advisor and the Director of Graduate Studies. Instructor: Staff. 1 unit.

399. Special Readings in Mechanical Engineering. Individual readings in advanced study and research areas of mechanical engineering. Approval of director of graduate studies required. 1 to 3 units. Instructor: Staff. Variable credit.

English

Professor Tennenhouse, Chair (312 Allen); Associate Professor Psomiades, Director of Graduate Studies (316 Allen); Professors Aers, Aravamudan, Armstrong, Baucum, Beckwith, Clum, Davidson, Ferraro, Holloway, Khanna, Moi, Pfau, Pope, Porter, Price, Quilligan, Smith, Strandberg, Tennehouse, Torgovnick, Wald; Associate Professors Harris, Holland, Jones, Mitchell, Moses, Moten, Psomiades, Somerset, Sussman, Tetel, Wallace; Assistant Professor Metzger; Professor of the Practice Hijuelos; Associate Professor of the Practice Malouf; Adjunct Professors Andrews and O’Barr; Lecturer Carlson-Hijuelos; Senior Lecturing Fellows Gopen, Donahue; Lecturing Fellows Fox, Hillard

The department only admits students seeking a PhD (though see below on JD/MA). In addition to the dissertation, the PhD in English requires completion of a minimum of eleven courses, a reading proficiency in at least one foreign language (the specific language to be determined by the student’s major areas of academic concentration), and a preliminary examination of three subfields (one major, two minor) that consists of both a written and oral part by the end of the third year of study. Within six months of the preliminary exam, a dissertation chapter meeting is required with the thesis committee. A JD/MA degree is offered by the department in cooperation with the Law School. JD/MA students must apply for admission to the Law School, and must combine relevant course work in English with full-time work toward a law degree.

Particular faculty interests currently cutting across the chronological and geographical categorizations of literature include the cultural work of memory; orientalism; mourning, history and reconciliation; literatures and discourses of the Atlantic; diasporic literatures; religion; and science and technology. Students are encouraged to read broadly in English and American literatures (including four-nations British literature, English and America in the Black Atlantic, the Irish Atlantic and other Atlanticist literatures, Anglo-diaporic literatures, and postcolonial literatures). They are also encouraged to interrogate the constitution and writing of literary and cultural history, and to develop the specific range of linguistic, philosophical, and historical skills relevant to their chosen field and their chosen intervention therein.

For additional information, visit our Web site, http://english.duke.edu/grads/.

English (ENGLISH)

201S. Writing Poetry: Formal and Dramatic Approaches. A workshop comparing meter, stanza, and rhyme with free verse, to illuminate the freedom and form of all poetry. Narrative and conceptual content considered within the poem's emotive, musical dynamic. Group discussion of technique, personal aesthetic and creative process; revisions of poems. Instructor: Pope. 3 units.

202S. Narrative Writing. The writing of short stories, memoirs, tales, and other narrations. Readings from ancient and modern narrative. Close discussion of frequent submissions by class members. Instructor: Porter or Price. 3 units.

207A. Introduction to Old English. An introduction to the language of the Anglo-Saxon period (700-1100), with readings in representative prose and poetry. Not open to students who have taken 113A or the equivalent. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 207A.

212S. Special Topics is Middle English Literature: 1100 to 1500. Selected topics. Satisfies Area I requirement for English
majors. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 209S

213S. Chaucer and His Contexts. The first two-thirds of his career, especially Troilus and Criseyde. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 213S

214S. Special Topics in Seventeenth-Century Literature. Topics vary by semester. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units.

220S. Shakespeare: Special Topics. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 220S

221S. Special Topics in Renaissance Prose and Poetry: 1500 to 1660. Selected topics. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 221BS

235. Special Topics in Restoration and Eighteenth-Century Literature. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

235S. Special Topics in Restoration and Eighteenth-Century Literature (DS3). Seminar version of English 235. Instructor: Staff. 3 units.

241S. Romantic Literature: 1790 to 1830. Selected topics. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

245. Special Topics in Victorian Literature. Selected topics. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

245S. Special Topics in Victorian Literature. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

250S. Music in Literature and Philosophy: 1800-1945 (DS3). 3 units. C-L: see German 280S; also C-L: International Comparative Studies 280CS

251. British Literature since 1900. Selected topics. Satisfies the Area III requirement for English majors. Instructor: Staff. 3 units.

262. American Literature to 1820. Selected Topics. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

271BS. Special Topics Seminar I. Seminar version of 288. Subjects, areas or themes that cut across historical eras, several national literatures, or genres, medieval and early modern period. Satisfies Area I requirement for English majors. Instructor: Staff. 3 units.

271C. Selected Topics in Feminist Studies (DS3 or DS4 as determined by instructor). Instructor: Staff. 3 units.

271CS. Special Topics Seminar III (DS3). Subjects, areas or themes that cut across historical eras, several national literatures, or genres. Satisfies Area II requirement for English majors. Topics course. Instructor: Staff. 3 units.

271ES. Special Topics Seminar III. Subjects, areas or themes that cut across historical eras, several national literatures, or genres, 1660 to the present. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

271FS. Special Topics Seminar in Criticism, Theory, or Methodology. Seminar Version of 288. Satisfies the Criticism, Theory, or Methodology (CTM) for English majors. Instructor: Staff. 3 units.

272S. Wittgensteinian Perspectives on Literary Theory, 3 units. C-L: see Literature 272S

276. Theater in London: Text. 3 units. C-L: see Theater Studies 216

277. Theater in London: Performance. 3 units. C-L: see Theater Studies 251

280. Twentieth-Century Reconceptions of Knowledge and Science (DS4). 3 units. C-L: see Literature 260


288B. Special Topics I. Subjects, areas or themes that cut across historical eras, several national literatures, or genres, medieval to early modern periods. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units.

288C. Special Topics II. Subjects, areas or themes that cut across historical eras, several national literatures, or genres, eighteenth and nineteenth centuries. Satisfies Area II requirement for English majors. Instructor: Staff. 3 units.

288E. Special Topics III. Subjects, areas or themes that cut across historical eras, several national literatures, or genres, 1860-Present. Satisfies Area III requirement for English majors. Instructor: Staff. 3 units.

288F. Special Topics in Criticism. Satisfies the Criticism, Methodology, Theory (CTM) requirement for English majors. Instructor: Staff. 3 units.

299S. Special Topics in Linguistics. Instructor: Staff. 3 units.

312. Studies in Middle English Literature, Instructor: Aers, Beckwith, or Somerset. 3 units.

315. Studies in Chaucer. Instructor: Aers, Beckwith, or Somerset. 3 units.

321. Studies in Renaissance Literature. Instructor: DeNeef, Porter, or Shannon. 3 units.


Environmental Science and Policy
Professor Chameides, Dean; Professor Katul, Director of Graduate Studies (A309A Levine Science Research Center); Professors Albertson, Christensen, Clark, DiGiulio, Hinton, Katul, Kramer, Levin, Linney, Medina, Oren, Pimm, Reckhow, Reynolds, Richardson, Richter, Salzman, Urban, Vincent, Wiener, and Wolpert; Associate Professors Kasibhatla, Murray, Newell, Pattanayak, Porporato, Pierce, Smith, Timmons, and Weinthal; Assistant Professors Anderson, Benneal, Bernhardt, Meyer, Patino-Echeverri, Stapleton; Professor Emeritus Healy, Knoerr, Schlesinger, Terborah; Professors of the Practice

The University Program in Environmental Policy is jointly administered by the Nicholas School of the Environment and the Sanford School of Public Policy. It is a multidisciplinary, research-focused five-year doctoral degree, intended to prepare candidates for positions in applied academic departments and professional schools, domestic and international public agencies and environmental organizations, research institutes, and policy consulting firms. Although the program is multidisciplinary, it is designed to ensure that students have strength in a particular social science discipline. Students designate their concentration when applying and currently may select either environmental economics or environmental politics. Coursework is offered through the Nicholas School, the Sanford School, the Department of Economics, and the Department of Political Science.

Major and minor work for the Environment Graduate Program is offered through the Environmental Sciences and Policy Division of the Nicholas School of the Environment and Earth Sciences. The research emphasis of the Environmental Sciences and Policy Division is in the areas of Ecosystem Science and Management, Environmental Chemistry and Toxicology, Aquatic and Atmospheric Sciences, and Environmental Social Sciences. College graduates who have a bachelor’s degree in one of the natural or social sciences, forestry, engineering, business, or environmental science will be considered for admission to a degree program. Students will be restricted to the particular fields of specialization for which they are qualified academically. Graduate School programs usually concentrate on some area of natural resource and environmental science/ecology, systems science, or economics/policy, while study in resource and environmental management is more commonly followed in one of the professional master’s degree programs of the Nicholas School of the Environment and Earth Sciences. For more complete program descriptions and information on professional training in forestry or environmental studies, the Bulletin of Duke University: Nicholas School of the Environment and Earth Sciences should be consulted.

School of the Environment faculty normally accept to the academic degree program only those students who wish to pursue a PhD degree. Applicants are strongly encouraged to contact the individual faculty member under whose supervision they are interested in pursuing graduate study. Information about each faculty member’s area of research interest can be found in the Nicholas School of the Environment bulletin and on the school’s Web site located at http://www.env.duke.edu. The degree is available for students enrolled in the joint law program, and the MS degree may be awarded as part of the doctoral program. Students generally are not admitted to the and MS tracks as stand alone programs in the Nicholas School with the exception of the Division of Earth and Ocean Sciences, which accepts students to a MS track. (See the Earth and Ocean Sciences section in this chapter for additional information.)

Environment Courses (ENVIRON)

200. Integrated Case Studies. A group of two to four students may plan and conduct integrated research projects on a special topic, not normally covered by courses or seminars. A request to establish such a project should be addressed to the case studies director with an outline of the objectives and methods of study and a plan for presentation of the results to the school. Each participant's adviser will designate the units to be earned (up to six units) and evaluate and grade the work. Instructor: Staff. Variable credit.

201. Forest Resources Field Skills. Introduction to field techniques commonly used to quantify and sample forest resources: trees, soils, water, and animal resources. Dendrology, vegetation sampling, soil mapping, river flow estimation, field water quality sampling, surveying, and use of compass. Instructor: Richter. 2 units.

203. Conservation Biology: Theory and Practice. An overview of biological diversity, its patterns, and the current extinction crisis. Historical and theoretical foundations of conservation, from human values and law to criteria and frameworks for setting conservation priorities; island biogeography theory, landscape ecology, and socioeconomic considerations in reserve design; management of endangered species in the wild and in captivity; managing protected areas for long term viability of populations; the role of the landscape matrix around protected areas; and techniques for conserving biological diversity in semiwild productive ecosystems like forests. Three field trips. Prerequisite: one ecology course or consent of instructor. Instructor: Pimm. 3 units.

205L. Ecological Management of Forest Systems (Silviculture). The aim of the course is to equip future resource managers and environmental consultants with knowledge allowing them to propose lower impact practices to individuals and organizations who need to balance wood production with maintenance of environmental quality. Underlying principles of growth, from seed to mature trees, and stand dynamics are explored. Various alternative methods of manipulating growth, stand structure and development, ranging from little to large perturbations of forest systems, are presented and assessed in terms of their effect on resource quality. Includes laboratory. Instructor: Doggett. 3 units.

206. Forest Vegetation Sampling. Theory and application of forest vegetation sampling. Direct and indirect estimation methods that range from timber cruising and inventory to sampling for species composition. Laboratory applications in Duke Forest to include over- and understory vegetation. Instructor: Doggett. 3 units.

207. Forest Health Management. Non-lab version of Environment 207L. Instructor: Staff. 3 units.

207L. Forest Health Management. Fundamentals of forest fire management, entomology and plant pathology (including air pollution and chemical damage) related to understanding their impacts on forest productivity and forest management. Regional case examples and complexes are evaluated in terms of pest-population, forest-stand dynamics; economic and societal constraints; treatment strategies; monitoring systems; and benefit-cost analysis. Approach seeks to develop predictive capabilities in long range pest management and decision making. Field oriented lab focuses on diagnostics and impact analysis. Instructor: Staff. 4 units.

208. Estuarine Ecosystem Processes. A study of the physical, chemical, geological, and biological processes that control the structure of estuarine communities. Includes readings, oral presentations, and discussion of current literature from the journal
Estuaries. Discussions focus on the management and policy implications of the science. Restricted to graduate students. (Given at Beaufort.) Prerequisite: ecology, systematics, or field biology course or consent of instructor. Instructor: Staff. 3 units.

209. Conservation Biology and Policy. Introduction to the key concepts of ecology and policy relevant to conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/rehabilitation). Open to undergraduates only under Biology 109. (Given at Beaufort.) Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course. Instructors: Crowder/Orbach (Beaufort). 3 units.

210. Applied Data Analysis for Environmental Sciences. Graphical and exploratory data analysis; modeling, estimation, and hypothesis testing; analysis of variance; random effect models; nested models; regression and scatterplot smoothing; resampling and randomization methods. Concepts and tools involved in data analysis. Special emphasis on examples drawn from the biological and environmental sciences. Students to be involved in applied work through statistical computing using software, often S-plus, which will highlight the usefulness of exploratory methods of data analysis. Other software, such as SAS, may be introduced. Instructor: Qian. 3 units. C-L: Statistical Science 240

211. Energy and Environment. Overview of the challenges confronting humanity as a consequence of our reliance on energy. Challenges include dwindling supplies, rising demand and environmental degradation. Realistic responses require an understanding of the complexity of the energy system, including energy resources, uses, and impacts, in the context of social, political and economic imperatives. Lectures will be augmented by presentations from guest speakers from industry, government and non-profit organizations. Instructor: Pratson. 3 units.

212. Environmental Toxicology. Study of environmental contaminants from a broad perspective encompassing biochemical, ecological, and toxicological principles and methodologies. Discussion of sources, environmental transport and transformation phenomena, accumulation in biota and ecosystems. Impacts at various levels of organization, particularly biochemical and physiological effects. Prerequisites: organic chemistry and vertebrate physiology or consent of instructor. Instructor: Di Giulio. 3 units.

213. Forest Ecosystems. Emphasis on the processes by which forests circulate, transform, and accumulate energy and materials through interactions of biologic organisms and the forest environment. Ecosystem productivity and cycling of carbon, water, and nutrients provide the basis for lecture and laboratory. Instructor: Oren. 3 units.

214. Landscape Ecology. Emphasis on the role of spatial heterogeneity in terrestrial systems: its detection and description, agents of pattern formation, landscape dynamics and models, and the implications of heterogeneity of populations, communities, and ecosystems. Prerequisites: an intermediate-level ecology course, introductory applied statistics, and Environment 351, or consent of instructor. Instructor: Urban. 3 units.


217. Tropical Ecology. Ecosystem, community, and population ecology of tropical plants and animals with application to conservation and sustainable development. Prerequisite: a course in general ecology. Instructor: Staff. 3 units. C-L: Biology 215

219L. Marine Ecology. 4 units. C-L: see Biology 203L

220. Introduction to Geographic Information Systems. Introduction to Geographic Information Systems, software and analysis methods. Based on series of self-paced modules with all content provided over the Internet. Basic structure of vector and raster geographic data and spatial analysis methods. Intended to provide self-paced alternative for students interested in gaining an overview of current software and applications. Consent of instructor required. Instructor: Halpin. 2 units.

221L. Soil Resources. Emphasis on soil resources as central components of terrestrial ecosystems, as rooting environments for plants, and as porous media for water. Soil physics and chemistry provide the basis for the special problems examined through the course. Laboratory emphasizes field and lab skills, interpretive and analytical. Instructor: Richter. 3 units.

225. Coastal Ecotoxicology & Pollution. Nonlab version of Environmental Sciences and Policy 225L. Principles of transport, fates, food-web dynamics, and biological effects of pollutants in the marine environment. No laboratories. Short local field trips possible. (Given at Beaufort.) Prerequisites: introductory chemistry and biology. Instructor: C. Bonaventura. 3 units. C-L: Marine Sciences

226. Marine Mammals. Ecology, social organization, behavior, acoustic communication, and management issues. Focused on marine mammals in the southeastern United States (for example, bottlenose dolphin, right whale, West Indian manatee). Only open to undergraduates under Biology 126. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read or staff. 3 units.

226L. Marine Mammals. Laboratory version of Environment 226. Laboratory exercises consider social organization and acoustic communication in the local bottlenose dolphin population. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read, Reynolds, or staff. 4 units.
227. Biology and Conservation of Sea Turtles. Essential biology of sea turtles (evolution, anatomy, physiology, behavior, life history, population dynamics) and their conservation needs, emphasizing their role in marine ecosystem structure and function. Will integrate basic ecological concepts with related topics including conservation and management of endangered species, contributions of technology to management of migratory marine species, role of research in national and international law and policy, and veterinary aspects of conservation. Given at Beaufort. Field trip to Trinidad is required. Instructor permission is required. Prerequisite: Introductory Biology. Instructors: S. Eckert, K. Eckert. 3 units.

227L. Biology and Conservation of Sea Turtles. Biology including the anatomy, physiology, behavior, life histories, and population dynamics of sea turtles linked to conservation issues and management. Focus on threatened and endangered sea turtle species, with special attention to science and policy issues in United States waters. Includes field experience with the animals and with their habitat requirements. Sea turtle assessment and recovery efforts, fishery-turtle interactions, population modeling and state/national/international management efforts. Only open to undergraduates under Biology 125L. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: K. Eckert or S. Eckert. 4 units.

228L. Physiology of Marine Animals. Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Open to undergraduates only under Biology 150L. Four units (fall); six units (summer). (Given at Beaufort.) Prerequisites: introductory biology and chemistry. Instructor: Forward. Variable credit. C-L: Biology 253L

229L. Biochemistry of Marine Animals. Functional, structural, and evolutionary relationships of biochemical processes of importance to marine organisms. Open to undergraduates only under Biology 155L. Four units (fall and spring); variable credit (summer). (Given at Beaufort.) Prerequisites: Biology 25L and Chemistry 11L, 12L. Instructor: Rittschof (fall and summer). Variable credit. C-L: Biology 255L

231L. Models for Environmental Data. 3 units. C-L: see Biology 268L


238. Global Environmental Health: Economics and Policy. Social science perspective on global environmental health. Students will learn to identify primary environmental causes of high burden diseases such as malaria, diarrhea, and respiratory infections; describe how to measure socio-economic impacts of global environmental health diseases; discuss key policies to control global environmental health problems based on private prevention and therapeutic behaviors; and propose frameworks to empirically monitor and evaluate global environmental health policies. A sub-module will focus on climate change and water-borne diseases. Prerequisites: Introductory course in statistics. Instructor: Pattanayak. 3 units. C-L: Global Health Certificate 238, Public Policy Studies 237

239. Human Health and Ecological Risk Assessment. Topics central to both health and ecological risk assessment are explored. Basic concepts of hazard identification, dose-response relationships, exposure assessment, and risk characterization and communication are discussed in the context of both human health and environmental assessment. The basis and rationale for using specific, as well as extrapolated, scientific information and expert judgment, and the strengths and weaknesses of alternative approaches, are evaluated. Applications emphasizing real cases are used to illustrate the interdisciplinary process and products of risk assessment, as well as the regulatory use of the information. Group projects emphasized. Instructors: Mihai and McMasters. 3 units.

240. Chemical Fate of Organic Compounds. Equilibrium, kinetic, and analytical approaches applied to quantitative description of processes affecting the distribution and fate of anthropogenic and natural organic compounds in surface and groundwaters, including chemical transfers between air, water, soils/sediments, and biota; and thermochemical and photochemical transformations. The relationships between organic compound structure and environmental behavior will be emphasized. Sampling, detection, identification, and quantification of organic compounds in the environment. Prerequisites: university-level general chemistry and organic chemistry within last four years. Instructor: Stapleton. 3 units. C-L: Civil Engineering 240

242. Environmental Aquatic Chemistry. 3 units. C-L: see Civil Engineering 242

243. Respiratory Proteins and the Environment. 3 units. C-L: see Cell Biology 243

244S. Collective Action, Environment & Development. 3 units. C-L: see Public Policy Studies 223S
245. **Economic Evaluation of Sustainable Development.** 3 units. C-L: see Public Policy Studies 227


247. **Survey of Environmental Health and Safety.** Environmental risks from the perspective of global ecology, biology, chemistry, and radiation. The nature and scope of environmental hazards, environmental impacts and health effects, and risk assessment and management strategies. Open to undergraduates by consent. Instructor: Thomann. 3 units.

248. **Solid Waste Engineering.** 3 units. C-L: see Civil Engineering 248

249. **Green Futures: Exploring Environmental, Economic, and Social Sustainability.** Theory and application of environmentally and socially sustainable practices in settings including businesses, academic institutions, and personal lives. Ethical concerns that accompany modern local and global environmental problems. Challenges, trade-offs between costs and benefits, and potential solutions to different greening options. Topics include alternative energy production and consumption, sustainable agriculture practices, resource conservation, environmental assessments, economic questions and social responsibility. (Given at Beaufort.) Prerequisites: None for graduate students. Undergrads: Introductory Biology and Environmental Science and Policy or consent of instructor. Instructor: Rittschof. 3 units. C-L: Marine Sciences

251D. **International Conservation and Development.** Interrelated issues of conservation and development. Topics include the evolution of the two concepts and of theories regarding the relationship between them, the role of science, values, ethics, politics and other issues in informing beliefs about them, and strategies for resolving conflicts between them. While attention will be given to all scales of interaction (i.e. local, regional, national, international), the focus will be on international issues and the `north-south' dimensions of the conservation and development dilemma. Examples from marine and coastal environments will be highlighted. Consent of instructor required. (Given at Beaufort.) Instructor: Campbell. 3 units. C-L: Marine Sciences

252. **Sustainability and Renewable Resource Economics.** Economic theories of sustainability, contrasted with other scientific views. Focus on renewable resource economics, modeling, and management. Prerequisite: Environment 270. Instructor: Smith. 3 units.

253L. **Sensory Physiology and Behavior of Marine Animals.** Sensory physiological principles with emphasis on visual and chemical cues. Laboratories will use behavior to measure physiological processes. Only open to undergraduates under Biology 156L. (Given at Beaufort.) Prerequisites: introductory biology and chemistry. Instructor: Rittschof. 4 units.

254. **Qualitative Research Design in Marine Studies.** Examination of the concept of research (philosophy, epistemology, practice) along with methods used widely in the social sciences. Focus is on qualitative methods, and related research ethics, objectives, design, data collection, analysis, and presentation. Consideration of utility of qualitative methods for understanding activities and policy in the marine and coastal environment. (Given at Beaufort.) Instructor: Campbell. 3 units.

255. **Applied Regression Analysis.** Linear regression using both graphical and numerical methods. Model construction, critique, and correction using graphical residual analysis. One-way and two-way analysis of variance; introduction to design of experiments. Use of a standard statistical software package. Applications and examples drawn from various sources, emphasizing the biological and environmental sciences. Prerequisite: Statistics 210B or equivalent. Instructor: Qian. 3 units. C-L: Statistical Science 242

2568. **Seminar in Ocean Sciences.** Biological, chemical, physical, and geological aspects of the ocean and their relation to environmental issues. Consent of instructor required. (Given at Beaufort.) Instructor: Staff. 2 units. C-L: Marine Sciences

259. **Fundamentals of Geographic Information Systems and Geospatial Analysis.** Fundamental aspects of geographic information systems and satellite remote sensing for environmental applications. Covers concepts of geographic data development, cartography, image processing, and spatial analysis. Gateway into more advanced training in geospatial analysis curriculum. Consent of instructor required. Instructor: Halpin. 4 units.

260. **Western Field Trip.** One-week trip to observe land management and utilization practices in the western United States. Exposure to ecological, economic, and policy issues, as well as watershed, wildlife, and land use questions. May be repeated for credit. Consent of instructor required. Instructor: Edeburn. 1 unit.

261. **Geospatial Analysis for Conservation Management.** Application course focusing on spatial analysis and image processing applications to support conservation management. Habitat mapping, spatial analysis of animal movements, habitat modeling, and the optimization of nature reserve selection. Requires a fundamental knowledge of geospatial analysis theory and analysis tools. Consent of instructor required. Prerequisite: Environment 259. Instructor: Swenson. 4 units.

262. **Forest Management Traveling Seminar.** Covers current topics in the broad field of forest management. Taught as a set of coordinated field trips with expert contacts in sites in the Carolina piedmont, coastal plain, and mountains. Topics of past seminars include fiber utilization, best management practices, forest regeneration, the chip mill issue, forest-pest management, and forest preservation management. May be repeated for credit. Instructor: Richter. 1 unit.

264. **Applied Differential Equations in Environmental Sciences.** General calculus and analytic geometry review; numerical differentiation and integration; analytic and exact methods for first and second order ordinary differential equations (ODE); introduction to higher order linear ODE, numerical integration of ODEs and systems of ODEs; extension of Euler's method to partial differential equations (PDE) with special emphasis on parabolic PDE. Example applications include population
293. Analysis of Ocean Ecosystems. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Staff. Variable credit. 4 units.

Biology 123. (Given at Beaufort.) Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Staff. 3 units. C-L: Economics 270, Public Policy Studies 272

Environmental and resource policy issues. Benefits and costs of policies related to sustaining resource productivity and maintaining environmental quality will be analyzed using economic and econometric methods. Topics include benefit-cost analysis, intergenerational equity, externalities, public goods, and property rights. Prerequisite: Environment 270 or equivalent; Economics 149 recommended. Instructor: Vincent. 3 units. C-L: Economics 273

Economic Analysis of Resource and Environmental Policies. Case and applications oriented course examining current environmental and resource policy issues. Intertemporal resource allocation, benefit-cost analysis, valuation of environmental goods and policy concepts. Prerequisite: introductory course in microeconomics. Instructor: Bennear or Smith. 3 units. C-L: Economics 270, Public Policy Studies 272D

Economic Analysis of Resource and Environmental Policy (DISCUSSION). Discussion section for Environ 270. Instructor consent required. Instructor: Bennear. 3 units. C-L: Economics 270D, Public Policy Studies 272D

271. Economic Analysis of Resource and Environmental Policies. Case and applications oriented course examining current environmental and resource policy issues. Intertemporal resource allocation, benefit-cost analysis, valuation of environmental goods and policy concepts. Prerequisite: introductory course in microeconomics. Instructor: Bennear or Smith. 3 units. C-L: Economics 270, Public Policy Studies 272D

272. Evaluation of Public Expenditures. 3 units. C-L: see Public Policy Studies 261; also C-L: Economics 261

273. Marine Fisheries Policy. Principles, structure, and process of public policy-making for marine fisheries. Topics include local, regional, national, and international approaches to the management of marine fisheries. A social systems approach is used to analyze the biological, ecological, social, and economic aspects of the policy and management process. (Given at Beaufort.) Instructor: Orbach. 3 units. C-L: Marine Sciences

274. Environmental Politics. 3 units. C-L: see Public Policy Studies 274

275S. Protected Areas, Tourism, and Development. Investigates issues of establishing and managing national parks, biosphere reserves, and other protected areas in situations where local populations compete for the same resources. Tourism is considered as a possible source of negative impacts on the protected area and as a source of local economic development. Includes consideration of tourism policy, resource protection strategies, microenterprise development, sustainable agriculture, and forestry. Instructor: Staff. Variable credit.

276. Marine Policy (A). Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Consent of instructor required. (Given at Beaufort.) Instructor: Orbach. 3 units. C-L: Public Policy Studies 297, Political Science 264

277. Professional Ethics for Environmental Practitioners. Give students training and experience in applying moral reasoning to the types of ethical problems likely to be encountered by environmental practitioners. Instructor: Maguire. 1 unit.

279. Introduction to Atmospheric Chemistry. A broad overview of the science of oxidant chemistry in the atmosphere. Basic physical and chemical concepts relevant to the understanding of atmospheric chemistry; several contemporary topics discussed from a process-level perspective. Topics include atmospheric structure and chemical composition; atomic structure and chemical bonds; chemical thermodynamics and kinetics; atmospheric radiation and photochemistry, tropospheric and stratospheric ozone chemistry; aqueous-phase atmospheric chemistry; atmospheric aerosols; and air quality modeling. Prerequisites: one college-level course each in chemistry and calculus. Instructor: Kasibhatla. 3 units. C-L: Civil Engineering

280. Social Science Surveys for Environmental Management. Social science research methods for collecting data for environmental management and policy analysis. Sampling, survey design, focus groups, pretesting, survey implementation, coding, and data analysis. Team projects emphasize development and practice of survey skills. Prerequisite: introductory applied statistics or equivalent. Instructor: Kramer. 3 units.

282. Biogeochimstry. 3 units. C-L: see Biology 272

285. Land Use Principles and Policy. 3 units. C-L: see Public Policy Studies 285

292L. Biological Oceanography. Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Four units (spring); six units (summer). (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Staff. Variable credit.

293. Analysis of Ocean Ecosystems. The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum's ecosystem concept; structure and function of the earth's major ecosystems. Open to undergraduates only under Biology 123. (Given at Beaufort.) Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor:
294. Water Quality Skills. Introduction to field and laboratory techniques for monitoring water quality characteristics including heat properties, BOD, flow, dissolved oxygen, nutrients, benthic invertebrates, and coliform indicators. Emphasis on technical report writing. Prerequisite: Environment 236. Instructor: Staff. 3 units.

295L. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 176L, Biology 274L, or Zoology 274L. Open to undergraduates only under Biology 176L. Four units (fall, spring, and Summer Term II); six units (Summer Term I). (Given at Beaufort fall, spring, and summer or at Bermuda, spring.) Prerequisite: Biology 25L. Instructors: Dimock (Beaufort) or Kirby-Smith (Beaufort); Wood (Bermuda). Variable credit. C-L: Biology 274L

296. Environmental Conflict Resolution. Practical techniques and scholarly underpinnings of environmental conflict resolution, including interest-based negotiation, mediation, public disputes, science-intensive disputes, and negotiation analysis. In-class time will be spent conducting negotiation role plays of increasing complexity and then debriefing them. Outside of class, students will prepare for the role plays and read background material to aid in debriefing. Students will keep a journal of their experiences. Consent of instructor required. Instructor: Maguire. 2 units.

298. Special Topics. Content to be determined each semester. May be repeated. Instructor: Staff. Variable credit. C-L: Marine Sciences

298S. Special Topics. Seminar version of 298. Instructor: Staff. Variable credit.

299. Independent Studies and Projects. Directed readings or research at the graduate level to meet the needs of individual students. Consent of instructor required. Units to be arranged. Instructor: Staff. Variable credit.

302. Program Management for Environmental Professionals. Overview of principles of program management, with application to diverse environmental professions. Lectures, case studies and discussion focus on topics including leadership, organizational structures, managing complex systems, adaptive management, risk and uncertainty, and advocacy within an organization. MEM and MF students only. Instructors: Christensen and Gallagher. 3 units. 4 units.

303. Principles of Environmental Modeling. 3 units. C-L: see Biology 303

309. Wetland Restoration Ecology. Restoration of wetlands requires understanding of wetland hydrology, biogeochemical processes, decomposition, community habitat requirements and soil processes. Factors are discussed in an ecosystem context along with current restoration techniques. Course utilizes newly constructed wetlands in Duke Forest to explore wetland restoration principles. Students teamed together to develop restoration plan for a restored wetland. Final report and oral presentation required. Instructor: Richardson. 3 units.

310. Topics in Environmental and Ecological Statistics. Project-based course on environmental and ecological statistics for PhD/MS students. Students work on specific data analysis projects associated with current research. Class consists of modules based on specific topics. Students required to complete introduction module and one additional module. Presentation and discussion of projects after introduction module required. Objective of class to provide statistical guidance in students' thesis research work. Instructor: Qian. 3 units.

312. Wetlands Ecology and Management. The study of bogs, fens, marshes, and swamps. Emphasis on processes within the ecosystem: biogeochemical cycling, decomposition, hydrology, and primary productivity. Ecosystem structure, the response of these systems to perturbations, and management strategies are discussed. A research project is required. Prerequisites: one course in ecology and chemistry. Instructor: Richardson. 3 units.

313. Advanced Topics in Environmental Toxicology. Discussion of current issues. Topics vary but may include chemical carcinogenesis in aquatic animals; biomarkers for exposure and sublethal stress in plants and animals; techniques for ecological hazard assessments; and means of determining population, community, and ecosystem level effects. Lectures and discussions led by instructor, guest speakers, and students. Prerequisite: Environment 212. Instructor: Di Giulio. 3 units.

314. Integrated Case Studies in Toxicology. 1 unit. C-L: see Pharmacology and Cancer Biology 314

315. Focused Topics in Toxicology. A contemporary advanced toxicology research area covered with readings from the current primary literature. An integrative review of the topic prepared as a collaborative effort. Consent of instructor required. Prerequisites: Pharmacology 233 and 347. Instructor: Levin. 1 unit. C-L: Pharmacology and Cancer Biology 315

317. Tropical Forests and Global Change. Tropical ecologists labor to understand how the diversity and dynamics of humid tropical forests are being affected by land use change in the form of ecosystem loss, fragmentation and disturbance regimes. More recently ecologists have begun to realize the complex synergies at various scales that link climate change and land use change in the tropics. Course will consider causes, consequences and possible mitigations of global change for tropical forests in the context of the fundamental ecology of tropical forested ecosystems. Instructor: Bynum. 3 units.

319. Mechanisms in Environmental Toxicology. Provides an in-depth examination of key molecular and biochemical mechanisms by which organisms defend themselves against environmental pollutants. Cellular mechanisms by which chemicals produce toxicity when the defense systems are overwhelmed will be addressed. Includes examinations of "state of the art" approaches for experimentally elucidating these phenomena. Course format will be that of a graduate seminar, with lectures given and discussions led by the instructors, guest speakers, and course participants. Prerequisites: one course in biochemistry and one course in toxicology. Instructors: Di Giulio. 3 units.

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320. Ecosystem Management. Principles of environmental management in the context of arbitrary temporal and spatial boundaries, complexity, dynamic processes, uncertainty and varied and changing human values. Topics to include adaptive management, decision making in the content of uncertainty, conflict resolution, strategic planning, evaluation and accountability. Case studies will cover terrestrial, aquatic and marine ecosystems and an array of social and institutional settings. Instructor: Christensen. 3 units.

321. Advanced Readings in Soil Science. An advanced discussion course based on readings that concern current critical topics in the soil sciences. Readings are selected from both basic and applied aspects of the field. Instructor: Richter. 1 unit.

322. Coastal Watershed and Policy. Examine hydrology of coastal watersheds and how watersheds modifications impact estuaries and near shore coastal ecosystems. Hydrologic functioning of natural unaltered watersheds is contrasted with changes caused by man's modification of those systems. Include discussion of efforts to remedy impacts through installation of Best Management Practices and wetlands restoration. Emphasis on gaining understanding of what the impacts of hydrologic change are on biology of coastal waters as watershed development alters the physics, chemistry, and geology of coastal waters. Includes field trips to watersheds in coastal North Carolina. Instructor: Staff. 3 units.

324. Marine Conservation Biology. Focus on the ecological effects of fishing, the major threat to marine biodiversity, by examining selected case studies, discussing conservation strategies, and learning how science and policy can be integrated to solve real-world problems. We will use the recent report of the Pew Oceans Commission as the starting point of our discussion. Taught at Beaufort. Trip to Hawaii is required. Permission of the instructor is required. Instructor: Read. 3 units.

328. Governance of Social-Ecological Systems. Focus on understanding the complex interactions between human and natural systems and how they can lead to sustainable futures. Introduction to leading concepts, theories, models, and analytical frameworks to advance understanding of the dynamics of social-ecological systems. Gulf of California, Mexico will be used as a case study. Students will gain first hand experience with empirical cases. (Given at Beaufort) Instructor: Basurto. 3 units.

329. Data and Time Series Analysis in Marine Sciences. Analysis of environmental time-series and other data sets. Topics include discrete sampling issues, data rejection and interpolation, coordinate rotations and principal axes, curve fits, regression, error and propagation of uncertainty, bootstrapping, filtering, spectral analysis, harmonic analysis, EOFs, wavelets. Lectures, workshops and homework assignments will apply these methods to environmental data sets. Each student will complete a final project, applying methods covered in class to data sets they choose, as part of or related to their research. Consent of instructor required. Instructor: Hench. 4 units.


350. Program Evaluations of Environmental Policies. Designed to give students foundation in methods and applications of quantitative program evaluation in environmental policy. Program evaluation seek to identify casual effect of program/regulation/policy on some outcome of interest using statistical methods. Students will learn major empirical methods in program evaluation and apply them to current environmental policies. Spring. Instructor: Bennear. 3 units.

352. Spatial Analysis in Ecology. Techniques of spatial analysis as applied to ecological data, including scaling techniques, pattern analysis, indices of patchiness (adjacency, contagion), and inferential methods (cross-correlation, permutation procedures). Emphasis on hands-on applications in computer lab. Prerequisite: Environment 214 or consent of instructor. Instructor: Urban. 3 units.

353. Advanced Topics in Landscape Ecology. Small groups of students working together to complete a project in landscape analysis integrating remote sensing, geographic information systems, spatial analysis, and simulation modeling. Expectation is that each student will have experience in at least one of these areas. Consent of instructor required. Offered on demand. Instructors: Halpin and Urban. Variable credit.

354. GIS Analysis for Conservation Management. This course explores applications of geographical and spatial analysis to conservation management. Use of GIS systems and current environmental policies. Prior experience with GIS systems and consent of instructor required. Instructors: Halpin and Urban. 3 units.

356. Environmental Fluid Mechanics. Introduction to turbulent fluid flow and Navier Stokes equations; basic concepts in statistical fluid mechanics; development of prognostic equations for turbulent fluxes, variances, and turbulent kinetic energy; Monin and Obukhov similarity theory for stratified turbulent boundary layer flows; applications to CO2, water vapor, and heat fluxes from uniform and nonuniform surfaces; the local structure of turbulence and Kolmogorov's theory; turbulent energy transfer and energy cascade between scales; turbulence measurements in the natural environment. Prerequisite: Civil Engineering 122L, Mathematics 111 or 135, or equivalent. Instructor: Katul. 3 units.

357L. Satellite Remote Sensing for Environmental Analysis. Environmental analysis using primarily satellite remote
sensing. Theoretical and technical underpinnings of remote sensing (georectification, image analysis, classification) coupled with practical applications (land cover mapping, change analysis, ground truth techniques). Strong emphasis on hands-on processing and analysis. Will include variety of image types: multi-spectral, hyper-spectral, radar and others. Prerequisite: Envir 259 or consent of instructor. Instructor: Swenson. 4 units.

358. Multivariate Analysis in Community and Landscape Ecology. Assembly in a lab setting portfolios of strategies for interpreting multivariate ecological datasets such as those relating species abundance to environmental variables, focusing on techniques commonly used by vegetation scientists (for example, ordination, classification, etc.). Emphasis on using and interpreting UNIX and PC-based software. Consent of instructor required. Instructor: Urban. 3 units.

359. Advanced Geospatial Analysis. Provide training in more advanced skills such as: GIS database programming, modeling applications, spatial decision support systems and Internet map server technologies. The course requires a fundamental knowledge of geospatial analysis theory, analysis tools, and applications. Consent of instructor required. Prerequisites: Environment 259 and Environment 282 or 286. Instructor: Halpin. 3 units.

360S. Political Ecology. Seminar to examine concept of political ecology as means of conceptualizing conservation and development conflicts and solutions. Required symposium in each program area. Students present master's project research. Address questions about natural resource scarcity using modern capital theory and optimal control theory to derive core results. Two objectives: provide students with a solid foundation in theory of natural resource economics, emphasizing tools and theoretical breadth to enhance research and teaching. Second objective to highlight contemporary themes in theoretical and empirical resource economics. Designed for PhD students in economics, finance, agriculture and resource economics, or public policy (with economics concentration). Prerequisites: one year PhD-level microeconomic theory and econometrics; review of differential equations recommended. Consent of instructor required. Instructor: Emery. 3 units.

361. Natural Resource Economics. Addresses questions about natural resource scarcity using modern capital theory and optimal control theory to derive core results. Two objectives: provide students with a solid foundation in theory of natural resource economics, emphasizing tools and theoretical breadth to enhance research and teaching. Second objective to highlight contemporary themes in theoretical and empirical resource economics. Designed for PhD students in economics, finance, agriculture and resource economics, or public policy (with economics concentration). Prerequisites: one year PhD-level microeconomic theory and econometrics; review of differential equations recommended. Consent of instructor required. Instructor: Emery. 3 units.

362. Principles of Management. Provides introduction to business terminology and practices for environmental professionals. Introduce students to foundational concepts and language associated with the different functional areas of the firm and to some of the processes and tools available to organizational managers to enhance organizational effectiveness. Areas covered include finance and accounting, management and leadership, and organizations and strategy. Permission of instructor required. Instructor: Richter. 1 unit.

363. Multidisciplinary Approaches to Global Health. 3 units. C-L: Public Policy Studies 254

364. Seminar in Toxicology. 1 unit. C-L: Pharmacology and Cancer Biology 347

365. Environmental Law Clinic. Under supervision of Law clinical faculty, students work on current case and policy advocacy priorities as determined by Clinic’s Advisory Board. Cases and issues undertaken by the Clinic will vary. Skills training emphasizes skills needed to counsel clients, examine witnesses and to advocate effectively in rulemaking and litigation settings. One semester enrollment; 2 semesters with instructor consent. Minimum 100 hours of clinic work per semester plus weekly group training meetings. Must be in third semester in Nicholas School to enroll. Pre-requisite: LAW 235 Environmental Law. Instructor: Longest. 4 units.

366. Fire Ecology and Management. Principles underlying field of fire ecology and skillful application of fire to meet land management objectives are explored through guest lectures, training sessions, readings and assignments. Specific topics range from history of fire in America, to role of fire in landscape change, to relationship of fire to climate change. Prescribed burning and use of fire in the contemporary landscape are important topics in the class. Course credit: 1 unit. Instructor: Richter. 1 unit.

367. Principles of Management. Provides introduction to business terminology and practices for environmental professionals. Introduce students to foundational concepts and language associated with the different functional areas of the firm and to some of the processes and tools available to organizational managers to enhance organizational effectiveness. Areas covered include finance and accounting, management and leadership, and organizations and strategy. Permission of instructor required. Instructor: Richter. 1 unit.

368. Environmental Decision Analysis. Quantitative methods for analyzing environmental problems involving uncertainty and multiple, conflicting objectives. Topics include subjective probability, utility, value of information, multiattribute methods. Students will apply these tools to an environmental policy decision in a group project. Prerequisite: introductory applied statistics or equivalent. Instructor: Reckhow. 3 units.

369. Program Area Symposium. Required symposium in each program area. Students present master's project research. Pass/fail grading only. Instructor: Staff. 1 unit.

370. Master's Project. An applied study of a forestry or environmental management problem or a theoretical research effort. A seminar presentation of the objectives, methodology, and preliminary findings is required. A written (or other medium) report at the conclusion of the project is also required. Undertaken with the guidance of the student's adviser. Consent of instructor required. Pass/fail grading only. Instructor: Staff. Variable credit.

371. Environmental Communication for Behavior Change - Online Course. Course provides environmental professionals with a practical introduction to the strategies, methods, and tools of environmental communication that effectively lead to changes in behavior. Emphasis on practical, field-based tools. Intensive online course. Consent of instructor required. Instructor: Day. 1 unit.

372. DEL: Contemporary Scientific Understanding of Climate Change. This course will provide students with a broad, policy-relevant overview of contemporary scientific understanding of climate change. The recently-released IPCC Fourth Assessment Report (IPCC AR4) titled `Climate Change 2007' will provide the framework for discussion of various aspects of climate change, including the fundamental physical science basis, potential impacts and vulnerability, and mitigation of
climate change. For DEL-MEM students only. Instructor consent required. Instructor: Kasibhatla. 1 unit.

**484. DEL: Changing Tropical Ecosystems.** The tropical regions of the earth contain the majority of the world’s biological diversity, as well as the majority of the world’s human population and its cultural diversity. This course will identify the primary drivers of change for tropical ecosystems, with a particular focus on land use change and present and future effects of global climate change. Possible solutions and mitigations for the threats that face tropical ecosystems, and by extension, human populations in the tropics and globally will then be considered. Three credits with field component, two credits without. For DEL-MEM students only. Instructor: Bynum. Variable credit.

**497. Duke Environmental Leadership: Independent Studies and Projects.** Directed readings or research at the graduate level to meet the needs of individual students. For Duke Environmental Leadership-Master of Environmental Management students only. Instructor consent required. Instructor: Staff. Variable credit.

## Evolutionary Anthropology

**Professor Pusey, Chair;** Associate Professor Schmitt, **Director of Graduate Studies;** Professors Glander, Kay, Myers, Smith, Terborgh, Wray and Yoder; Associate Professors Alberts, Brannon, Churchill, Drea, Platt, Roth, and Taylor; Assistant Professor Hare; Associate Professor of the Practice Digby; Associate Research Professor Wall; Professors Emeritus Hylander and Simons; Research Professor Cartmill; Visiting Associate Professor Williams; Visiting Assistant Professors Cuddahoe and Schreier; Adjunct Professors Lambert, Rose, Struhsaker; Adjunct Associate Professors Ankel-Simons, Brockman, Brown; Adjunct Assistant Professors Bergl, Hanna, Linder, and Steenhuyse; Adjunct Assistant Research Professor Chatrath

Admission to the PhD program in evolutionary anthropology is not contingent on any particular course of study at the undergraduate level. The goal of the graduate program is to provide students with a broad-based background in organimsal biology with which to study the behavior, ecology, and evolution of primates. The three general areas of focus in the department are: (1) behavior, ecology, and genetics; (2) paleontology, systematics, and evolution; and (3) functional, comparative, and developmental morphology. Students are encouraged to define a course of study that crosses these areas of interest and that extends beyond the strict limits of primatology. Research opportunities include behavioral research at the Duke University Lemur Center; ecological and behavioral fieldwork in Africa, Central and South America, Asia, and Madagascar; paleontological fieldwork in Africa, South America, North America, and Madagascar; and laboratories in experimental functional morphology and comparative embryology.

Courses of study are tailored to meet individual needs, but all students will be expected to take gross human anatomy, a course in statistics and experimental design, and at least one course in each of the subfields of the department.

Students are required to demonstrate a reading knowledge of at least one language other than English.

For more information, visit the departmental Web Site at: [http://www.baa.duke.edu/](http://www.baa.duke.edu/), or e-mail to: daniel.schmitt@duke.edu.

### Evolutionary Anthropology Courses (EVANTH)

**208S. Human Embryology.** 4 units. C-L: see Biology 208S

**234L. Advanced Human Osteology.** Advanced laboratory techniques for human osteological analysis; identification and sizing of fragmented skeletal elements and teeth; differences between human and non-human bone; biomechanical analysis, functional morphology, hominin osteology; case studies of human skeletons used to produce written skeletal report. Prerequisite: 100-level course in osteology or general anatomy. Instructor: Staff. 3 units.

**238S. Primate Adaptation.** A study of primate adaptation from an evolutionary perspective. Topics vary according to student interests but may include history and functional significance of locomotor and feeding adaptations, craniofacial morphology, sense organs, reproductive systems, and language in primates, including humans. Seminar format but, depending on topic, may include laboratory analysis of materials. Prerequisite: 100-level anatomy or morphology course and consent of instructor. Instructor: Williams. 3 units.

**240S. Hominid Socioecology.** Analysis of how socioecological studies of human foragers and nonhuman primates can inform the interpretation of the hominid fossil/archaeological record. Summary of documented historical changes during hominid evolution, and identification of approaches required to develop testable reconstructions. Models for the evolution in hominids of bipedalism, ranging and foraging, hunting, food sharing, intersexual relationships and sexual division of labor, communication (including language), culture, technology, life history, parental care, and social organization, as well as their mutual relationships. Prerequisite: Evolutionary Anthropology and Anatomy 93(D) and 132. Instructor: Staff. 3 units.

**244L. Methods in Primate Field Ecology.** Survey of field methods used in the study of primate ecology, including habitat assessment, mapping, and behavioral observations using computer technology. Laboratory includes observations of primates at the Duke Lemur Center. Prerequisite: Evolutionary Anthropology 93; 100-level behavior or ecology course. Instructor: Glander. 3 units.

**245S. Primate Social Evolution.** Ecological determinants of, and biological constraints on, social strategies and systems, with an emphasis on primates. Prerequisite: Evolutionary Anthropology 93 and 100-level behavior course. Instructor: Staff. 3 units.

**246. The Primate Fossil Record.** A survey of fossil primates including early humans. The diversity, anatomy, and behavior of primates as related to the origin and spread of past primates. The radiation of each main group of primates in the succession
leading to humans illustrated with slides, casts, and fossils. Topics include geochemical dating, timing of molecular clocks, and various procedures for classifying primates. Prerequisite: Evolutionary Anthropology 93 and 100-level paleontology or anatomy course. Instructor: Simons or Staff. 3 units.

247. The Hominid Fossil Record. Origin and successive stages of development of human ancestors. Detailed analysis of adaptive types and cultural developments. Personalities and current controversies in the study of hominid paleontology. Prerequisite: Evolutionary Anthropology 93 and 132, or consent of instructor. Instructor: Simons or Staff. 3 units.

274. Genomic Perspectives on Human Evolution. 3 units. C-L: see Biology 274

280L. Special Topics Laboratory. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

280S. Seminar in Selected Topics. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

281L. Special Topics Laboratory. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

281S. Seminar in Selected Topics. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

287S. Macroevolution. 3 units. C-L: see Biology 287S

289L. Comparative Mammalian Anatomy. A practical survey of anatomical diversity in mammals. An emphasis on dissections of a broad variety of mammals. A broader perspective on specific anatomical features provided in the lectures. Consent of instructor required. Instructor: Staff. 3 units.

292. Research in Cognitive Evolution. Research and readings in cognitive evolution and anthropology. Students are expected to formulate research questions, develop research protocols, collect and analyze data; participation in group discussions. Instructor: Hare. 3 units.

293S. Advanced Research in Evolutionary Anthropology. Advanced research in Evolutionary Anthropology topic, typically leading to Graduation with Distinction. Course includes a one-hour weekly seminar on topics such as hypothesis testing, writing proposals, research design, data analysis with a strong emphasis on writing. Students will complete the introduction (literature review) and methods of their thesis along with a tentative results. Students are also expected to work with a faculty mentor conducting original research equivalent to a research independent study. Instructor consent required. Instructor: Digby, 3 units.

301. Anatomy of the Limbs. The musculoskeletal anatomy of the limbs and limb girdles. Emphasis is on detailed dissection of the extremities, with a minor focus on clinical applications. Course primarily intended for advanced graduate students in physical therapy. Consent of instructor required. 1 to 3 units. Instructor: Staff. Variable credit.

305. Gross Human Anatomy. Includes complete dissection of a cadaver; laboratory work is supplemented by conferences which emphasize biological and evolutionary aspects. Required of entering graduate students in anatomy; by arrangement, may extend into second semester. Prerequisites: adequate background in biology, including comparative anatomy and embryology and written consent of instructor. Instructor: Staff. 3 units.

312. Research. Individual investigations in the various fields of biological anthropology and anatomy. Consent of instructor required. Credit to be arranged; maximum 6 units. Instructor: Staff. Variable credit.

313. Anatomy Seminar. Regular meeting of graduate students and staff in which current research problems in anatomy will be presented. Instructor: Staff. 1 unit.

314. Concepts in Evolutionary Anthropology -A. Graduate seminar for first year graduate students covering the foundation principles of evolutionary anthropology. Instructor: Staff. 1 unit.

315S. Concepts in Evolutionary Anthropology. Introduction to topics that are considered central to Evolutionary Anthropology; Exposure to research and techniques used in the field; Develop skills in scientific inquiry, oral expression, and presentation; Familiarize students with the facilities/resources on campus that are associated with Evolutionary Anthropology. Consent Required. Part 2 of 2. Instructor: Staff. 3 units.

334. Topics in Physical Anthropology. Instructor: Staff. 3 units.

335S. Functional Morphology of the Hominid Fossil Record. Evolutionary and functional morphology of the hominini; emphasizing species in the genera Australopithecus, Paranthropus and Homo. Focus on biomechanical studies of 1) the masticatory apparatus as it relates to evolutionary shifts in diet, 2) upper limb function as it relates to the evolution of manipulative capabilities in the context of tool use, and 3) pelvic and lower limb morphology as it relates to the emergence of bipedal locomotion and changes in brain size and life history. Instructor: Churchill. 3 units.

340. Tutorial in Advanced Anatomy. Topics for intensive reading and discussion will be chosen according to the student's interests, related to basic problems in function of bone and muscle systems, development and differentiation, comparative anatomy at the gross and histological level and vertebrate evolution. Consent of instructor required. Instructor: Staff. Variable credit.

346S. Topics in Primate Behavior and Ecology. Advanced readings and discussion in primate behavior and ecology; emphasis on current issues and critical analysis of readings; topics vary each semester. Topics course. Instructor: Pusey. 3
354. Research in Biological Anthropology and Anatomy. A preceptorial course in various research methods in biological anthropology and anatomy. Consent of instructor required. Credit to be arranged. Instructor: Staff. Variable credit.

361S. Advanced Biometry. Advanced course in biological statistics. Principles of parametric and nonparametric statistics; hypothesis testing in biological anthropology. Topics include study design, analysis of variance, regression, and allometry. Student analysis of comparative anatomical and behavioral field data resulting in a research paper. Prerequisites: introductory statistics course. Consent of instructor required. Instructor: Wall. 3 units.

380S. Special Topics in Evolutionary Anthropology. Selected topics in Evolutionary Anthropology. Topics vary by semester. Instructor: Staff. 3 units.

393. Independent Study. Directed reading and research. Consent of instructor required. Instructor: Staff. 3 units.

Genetics

See "Genetics and Genomics" below, and also “Molecular Genetics and Microbiology” on page 130

Genetics and Genomics

Professor Marchuk, Director; Assistant Professor Hauser, Director of Graduate Studies; Professors Alberts (biology), Andrews (medicine), Been, (biochemistry), Benfey (biology), Capel (cell biology), Counter (pharmacology and cancer biology), Cullen (molecular genetics and microbiology), Dong (biology), Endow (cell biology), Garcia-Blanco (molecular genetics and microbiology), Goldstein (molecular genetics and microbiology), Greenleaf (biochemistry), Heitman (molecular genetics and microbiology), Hershfield (medicine), Hogan (cell biology), Hsieh (biochemistry), Jinks-Robertson (molecular genetics and microbiology), Jirtle (Radiation Oncology), Katsanis (cell biology), Keene (molecular genetics and microbiology), Kiehart (biology), Kirby (pediatrics), Kornbluth (pharmacology and cancer biology), Kreuzer (biochemistry), Lew (pharmacology and cancer biology), Linney (molecular genetics and microbiology), Marchuk (molecular genetics and microbiology), Marks (pathology), McClay (biology), McCusker (molecular genetics and microbiology), Means (pharmacology and cancer biology), Mitchell-Olks (biology), Modrich (biochemistry), Nevin (molecular genetics and microbiology), Nicklas (biology), Nijhout (biology), Noor (biology), Perfect (medicine), Petes (molecular genetics and microbiology), Rinetz (biochemistry), Rausher (biology), Shaw (chemistry), Steege (biochemistry), St. Geme (pediatrics), Sullenger (Surgery), Sun (biology), Thiele (pharmacology and cancer biology), Uyenoyama (biology), Vilgalys (biology), Willis (molecular genetics and microbiology), Willis (biology), Wray (biology), Young (ophthalmology); Associate Professors Aballay (molecular genetics and microbiology), Alspaugh (medicine), Ashley-Koch (medicine), Bejsovec (bio), Bowes-Rickman (cell biology), Cox (medicine), Cunningham (biology), Dietrich (molecular genetics and microbiology), Ferreira (molecular genetics and microbiology), Gregory (medicine), Gregory (medicine), Haase (biology), Hauser (medicine), Klingensmith (cell biology), Kuehn (biochemistry), Lutzoni (biology), Markert (pediatrics), Matsunami (molecular genetics and microbiology), McCarthy (medicine), Pickup (molecular genetics and microbiology), Pei (biology), Poss (cell biology), Rushe (biochemistry), Schachat (cell biology), Steinbach (pediatrics), Valdevia (molecular genetics and microbiology), F. Wang (cell biology), Wechsler-Reya (pharmacology and cancer biology), Winn (medicine), Zhuang (immunology); Assistant Professors Bagnat (cell biology), Baugh (biology), Buchler (biology), Chen (biology), Chi (molecular genetics and microbiology), Crawford (pediatrics), Dave (medicine), Eroglu (cell biology), Jiang (pediatrics), Lechler (cell biology), Liedtke (neurobiology), Luftig (molecular genetics and microbiology); Assistant Professor Kuehn; Associate Professors MacAlpine (pharmacology and cancer biology), Magwene (biology), Ohler (biostatistics and bioinformatics), Schonid (biology), Seed (pediatrics), Sherwood (biology), Soderling (cell biology), Sullivan (molecular genetics and microbiology), Tracey (cell biology), Unniraman (immunology), West (neurobiology), S. York (medicine), You (biomedical engineering); Associate Research Professors: Cardenas-Carona (molecular genetics and microbiology); Assistant Research Professors Koh (surgery), and N. Sherwood (biology); Adjunct Professors Drake (National Institute of Environmental Health Science), Kunkel (National Institute of Environmental Health Science), and Resnick (National Institute of Environmental Health Science)

A PhD or certificate is available in this program.

The Duke University Program in Genetics and Genomics (UPGG) is an umbrella graduate training program that spans several basic science and clinical departments and bridges the medical center and the college of arts and sciences. There are over 100 faculty with three adjunct faculty, and over 75 students in the program, which was founded in 1967 and has been continuously supported by a training grant from the NIH for the past 25 years. Over the past several decades, the program has served as an important forum for training and education in genetics, including model systems (bacteria, yeast, fungi, drosophila, zebrafish, mouse), population genetics, and human genetics. We recently forged a close link between the program and the emerging Institute of Genome Sciences and Policy (IGSP) at Duke.

The Duke UPGG is unique in that it is degree granting. Thus students can either receive their degree via the University Program in Genetics and Genomics, or via the host department that students affiliate with upon joining a laboratory for graduate training. The requirements for the two are different, since students who choose to earn their degree from the host department satisfy both UPGG and departmental requirements. However, in many cases, the requirements for the UPGG satisfy the departmental requirements.

These mechanisms ensure a great degree of flexibility in serving the needs of the member labs, 13 different departments, and ensure that students in the UPGG have both a common home and can pursue their own unique
career paths within the umbrella of the program.

The curriculum requirements for the Duke University Program in Genetics and Genomics are flexible. Students are required to take two full semester courses, Genetic Approaches to the Solutions of Biological Problems (UPG 378) and Evolutionary Genetics (UPG 287), one additional full semester course with an emphasis in genetics, and two minicourses selected from a variety of offerings. Courses for first year students are chosen in consultation with the Director of Graduate Studies and a first year advisory committee. Courses are available and encouraged for students past the first year of study, and decisions about additional coursework are made in consultation with the student's faculty advisor and committee to complement the requirements of the student's own research interests.

In addition to courses, students participate in other educational activities. These include an annual student organized retreat at the beach, and a biweekly student research seminar series. There is a two-semester genetics seminar series (jointly sponsored by the Duke IGSP) that is interspersed with four distinguished lecturer seminars, two in the spring and two in the fall. Students organize and invite the distinguished lecturer series with advice from a faculty committee member, and students host the dinners with the distinguished lecturers. Students have the opportunity to develop teaching skills as an assistant for one semester. Finally, students complete a preliminary examination at the end of the second year of graduate study and form their thesis committee.

Students admitted to the Program in Genetics and Genomics at Duke University may obtain a PhD by working with faculty of the interdepartmental University Program in Genetics and Genomics.

CERTIFICATE in GENETICS AND GENOMICS

Students admitted to the Program in Genetics and Genomics at Duke University may obtain a PhD in their host department, with certificate of graduate study in the University Program in Genetics and Genomics.

Certificate Requirements:
- Coursework: UPGEN 378, UPGEN 287, 6 credit hours in additional full-semester courses or mini-courses on any aspect of genetics (as approved by director of graduate studies).
- Research papers: one article in a refereed journal.
- Seminars: enrollment in UPGEN 316 (including giving one presentation), UPGEN 350, defense seminar.
- Examinations: preliminary exam, final exam/ defense.
- Event participation in a seminar series associated with UPGEN316 and UPGEN350 (which includes Distinguished Lecture Series).

For more information, visit [http://upg.duke.edu/](http://upg.duke.edu/).

University Program In Genetics Courses (UPGEN)

225. Critical Readings in Classical Human Statistical Genetics. In-depth readings of classical human statistical genetics papers that shaped the field including Morton's lod score analysis, Penrose's affected sibling pair studies, and the Elston-Stewart algorithm, among others. Student-led discussions of content. Instructors: Speer and Scott. 1 unit.

232. Human Genetics. 3 units. C-L: see Molec Genetics & Microbiology 232

233. Genetic Epidemiology. This course will cover traditional genetic epidemiologic methods such as study design, linkage analysis and genetic association. Instructor: Ashley-Koch. 3 units.

247. Macromolecular Synthesis. 2 units. C-L: see Cell and Molecular Biology 247

258. Structural Biochemistry I. 2 units. C-L: see Biochemistry 258; also C-L: Cell and Molecular Biology 258, Cell Biology 258, Immunology 258, Structural Biology and Biophysics 258, Computational Biology and Bioinformatics 258

259. Structural Biochemistry II. 2 units. C-L: see Biochemistry 259; also C-L: Cell Biology 259, Immunology 259, Computational Biology and Bioinformatics 259, Structural Biology and Biophysics 259

268. Biochemical Genetics II: From RNA to Protein. 2 units. C-L: see Biochemistry 268; also C-L: Cell Biology 268, Immunology 268

285S. Ecological Genetics. Interaction of genetics and ecology and its importance in explaining the evolution, diversity, and distribution of plants and animals. Instructor: Staff. 3 units.

286. Evolutionary Mechanisms. 3 units.

287. Evolutionary Genetics. An introduction to the principles of evolutionary genetics, with discussion of the current literature. Levels of selection; neutral theory; variation in populations; speciation. Reconstructing evolutionary history; genomic evolution. Instructor: Noor. 3 units.

288. Mathematical Population Genetics. 3 units.

301. Advanced Topics in Genetics and Genomics. Course open only to first year UPGG graduate class. Weekly discussion of current literature in genetics (Fall semester) and genomics (Spring semester). Permission of instructor required. Instructor: Staff. 2 units.

306. Writing Grant Proposals. A course to prepare students in writing grant proposals. Instructor: Marchuk. 2 units.
316. Genetics Student Research. Presentations by genetics program students on their current research. Required course for all graduate students specializing in genetics. Credit grading only. Instructor: Staff. 1 unit.

317. Independent Research for the Master's Degree. This course is an independent research course specifically for students who have been given the option by the DGS and their mentor to receive a Master's Degree from the Program. Any student taking this course must have permission from the DGS and from the instructor. Successful completion of the course will be determined by the instructor, the student's mentor, and the DGS. Instructor: Staff. Variable credit.

346. The Mouse as a Model Organism. 2 units. C-L: see Cell Biology 346

350. Genetics Colloquium. Lectures, discussion sections, and seminars on selected topics of current interest in genetics. Required of all students specializing in genetics. Prerequisite: a course in genetics. Instructor: Staff. 1 unit.

378. Genetic Approaches to the Solution of Biological Problems. Use of genetic approaches to address research problems in cell and developmental biology. Genetic fundamentals build up to modern molecular genetic strategies including genetic screens, reverse genetics, genetic interactions, dominant negative mutants, and more. Several major genetic model organisms used to illustrate general principles. Consent of instructor required for undergraduates. Instructor: Lew. 4 units. C-L: Cell and Molecular Biology 378, Molec Genetics & Microbiology 378, Biology 378

**German Studies, Carolina-Duke Graduate Program**

Associate Professor Donahue, Chair (German); Professor Pfau, Director of Graduate Studies and Co-Chair of Carolina-Duke Graduate Studies Program (English); Professor Downing, Co-Chair of Carolina-Duke Graduate Studies Program (UNC-CH German); Professors Gillespie (political science), Gilliam (music), Hillerbrand (religion), Jameson (literature), Kitschelt (political science), Koonz (history), Pfau (English), Rasmussen (German), Robisheaux (history), Stiles (art and art history), Steinmetz (divinity), Surin (literature), Todd (music), and Van Miegroet (art and art history); Associate Professors Campt (women’s studies), Coles (political science), Hacohen (history), Morton (German); Assistant Professor Norberg (German); Associate Professor of the Practice Walther (German); Adjunct Associate Professor Ward (philosophy)

As of fall 2009, the Carolina-Duke Graduate Program in German Studies is a fully merged graduate program that draws on the largest German Studies faculty in the country, as well as the considerable library holdings of each institution. Students apply to a single program and graduate with a diploma bearing the names of both Duke University and the University of North Carolina at Chapel Hill. Information about this program can be found at: [http://www.german.duke.edu/carolina-duke-grad/](http://www.german.duke.edu/carolina-duke-grad/). For additional information, contact Thomas Pfau at: pfau@duke.edu and Eric Downing at: ed Downing@email.unc.edu.

**A PhD in German Studies is available in this program.**

A total of 16 courses (including those listed below), two of which may be credit for work on a dissertation, are required. Five core courses are required: Foreign Language Pedagogy, Theories and Practices; Cultural Foundations in German Studies, to 1800; Midde High German; and German Linguistics. Incoming students who have satisfactorily completed equivalent graduate courses may be exempted by the Director of Graduate Studies and Graduate Advising (DGS) from one or more of the required courses. Nine additional elective courses must also be completed; two of these will be DGS-approved courses outside of the German Studies Program, which complement the student’s areas of interest in an interdisciplinary fashion.

A PhD Preliminary Exam is required, normally taken by the end of the third year. An oral dissertation defense, normally by the end of the fifth year, is also required. In addition, students are strongly encouraged to attend the program’s monthly "works in progress" seminar, at which faculty, advanced graduate students, and guests present their current research.

A list of courses offered at UNC-Chapel Hill as part of the Carolina-Duke Graduate Program in German Studies is available online at: [http://www.unc.edu/depts/german/courses/courseofferings.html](http://www.unc.edu/depts/german/courses/courseofferings.html).

**German Courses (GERMAN)**

201. German for Academic Research I. Introduction to German for the purpose of developing reading and translation skills necessary for pursuing academic research. Assumes no prior knowledge of German. Foundations of German grammar and syntax; emphasis on vocabulary and translations. Selected readings in theory of translation and techniques. Not open for credit to undergraduate students who have taken Intermediate German (65, 66, 69, or equivalent). Does not count toward the major or minor, or toward the fulfillment of the Foreign Language Requirement. Instructor: Staff. 3 units.

202. German for Academic Research II. Development and refinement of skills needed to read and translate intermediate to advanced academic German. Texts selected by instructor, with regular opportunities to work on materials related to individual fields/research topics. Selected readings in theory of translation and techniques. Prerequisite: German 201. Not open for credit to undergraduate students who have taken Intermediate German (65, 66, 69, or equivalent). Does not count toward the major or minor, or toward the fulfillment of the Foreign Language Requirement. Instructor: Staff. 3 units.

204S. German Business / Global Contexts. Current German economic and business debates and events. Germany's position in the global marketplace and on ensuing intercultural business encounters. Topics include state of Germany's industry and energy resources, monetary policies and banking systems, environmental concerns, foreign trade, taxes, and the social safety net. Attention to Germany's self-understanding as a "social market economy" and the compatibility of that model with current
trends in globalization. Instructor: Staff. 3 units.

209S. Introduction to Medieval German: The Language of the German Middle Ages and Its Literature. Basic reading skills in the medieval German language (Middle High German) developed by working with literary texts in their original idiom. Canonical texts such as courtly love poetry (Walther von der Vogelweide), Arthurian romance (Hartmann von Aue, Wolffram), and heroic epic (Nibelungenlied). Understanding manuscript culture, philological inquiry, medieval intellectual practices, relationship between learned Latin culture and educated vernacular cultures. Research paper required. Readings and discussion in German. Instructor: Rasmussen. 3 units. C-L: Medieval and Renaissance Studies 203S

210S. Sex, Gender, and Love in Medieval German Literature. Historical contexts for emergence of courtly love and the role of desire and interpretation in Gottfried von Strassburg's Tristan und Isolde, courtly love lyric, 'maere.' Instructor: Rasmussen. 3 units. C-L: Medieval and Renaissance Studies 203S

211S. Theory and Practice of Literary Translation. 3 units. C-L: see Literature 211S

221S. Literary Guide to Italy. 3 units. C-L: see Italian 221S; also C-L: Literature 280S

225S. Introduction to Goethe. Major works of lyric, narrative, drama, and theory, throughout Goethe's career. Readings and discussions in German. Instructor: Morton. 3 units.

226S. Goethe's Faust. Goethe's masterpiece and life's work, conceived as a summation of Western literature and mythology for the modern age. Readings and discussions in German. Instructor: Morton. 3 units.

245S. German Literature and Culture 1900-1945. Radical social shifts and their disruption of German culture and literary conventions during the first half of the 20th century. From the poetry, film, manifestos, and revolutionary theater of Expressionism, to the high modernism of Rilke, Kafka, Hesse, and Mann, to the didactic literary program of Brecht and his circle, including Kurt Weil and Marieluise Fleisser, to the internationalist goals of the Frankfurt School of Social Research. Emphasis on relations between text and history, from WWI to Weimar to the persecutions and systematic destructions of the Nazi era. Instructor: Donahue or Rolleston. 3 units.

247S. German Literature and Culture Since 1945. Major German literary, filmic, and cultural works since 1945. Topics vary: representations of National Socialism and the Holocaust in German culture; "Vergangenheitsbewältigung" (dealing with the past) in German literature and culture; history, memory, and national identity in German, Austrian, and Swiss literature. Instructor: Donahue or Norberg. 3 units.

255. Special Topics in German Literature and Culture. Topics vary by semester. Instructor: Staff. 3 units.

258S. Special Topics in German Literature and Cultural Studies. Instructor: Staff. 3 units.

260. History of the German Language. Phonology, morphology, and syntax of German from the beginnings to the present. Instructor: Keul or Rasmussen. 3 units. C-L: Medieval and Renaissance Studies 260B, Linguistics 260

261S. Second Language Acquisition and Applied Linguistics. Introduction to the fields of second language acquisition and applied linguistics. Investigation of competing theories of language acquisition and learning, and various aspects of applied linguistics, including language and cognition, language and power, bilingualism, language and identity, and intercultural communication. Taught in English. Instructor: Walther. 3 units. C-L: Linguistics 261S


270. Consciousness and Modern Society. The German tradition of political theory conceptualizing social transformation through consciousness both of alienation and of ethical ideals; the ongoing debate between activist and radically critical perspectives. Marx, Nietzsche, Lukacs, Freud, Benjamin, Adorno, Marcuse, and Habermas. Taught in English. Instructor: Rolleston. 3 units. C-L: Literature 270

272S. Fin-de-siècle and Interwar Vienna: Politics, Society, and Culture. 3 units. C-L: see History 272S

275S. Hegel's Political Philosophy (C-N). 3 units. C-L: see Political Science 236S; also C-L: Philosophy 236S

276S. Nietzsche's Political Philosophy (C-N). 3 units. C-L: see Political Science 226S; also C-L: Philosophy 237S


298S. Special Topics in German Studies. Special topics in German literature and cultural studies. Taught in English. Instructor: Staff. 3 units.

299S. Seminar in German Studies. Review of current debates and historical perspectives in the German cultural field, structured through contributing disciplines: social and economic history, political theory and history, literature, fine arts, music, philosophy, and religion. Team-taught, involving a wide range of faculty in the German Studies Program. Taught in English. Instructor: Donahue, Rolleston, and staff. 3 units. C-L: International Comparative Studies 280ES

300S. The Discipline of Germanistik: A Historical Survey. A study of trends in scholarly criticism within the context of German culture and politics beginning in the 1810s with the origins of Germanistik as a university discipline. Topics may include: the invention of philology and the romantic enterprise; positivism and Geistesgeschichte; the politics of Germanistik, 1933-45; Germanistik in Europe and the United States after 1945. Instructor: Borchardt or Rasmussen. 3 units.
301. German Studies: Theory and Practice. German studies at the intersection of various discourses (such as feminism, psychoanalysis, new historicism), questioning traditional concepts such as national identity, history, and language. Interdisciplinary issues may include: the relationship of literature, the unconscious and technology; the cinematic representation of Nazi history; architecture, monuments, and "German" space. Texts might include works by Kafka, Freud, Marx, Spengler, and Schinkel as well as texts by individuals whose work has been excluded from more traditional "Germanistik" courses. Instructor: Staff. 3 units.

302. Topics in Literary Theory. Literary theories and methods in their history and philosophical contexts. Issues include canonicity, German identity debates, and the claims of aesthetic language. Instructor: Staff. 3 units.

303. Topics in Literary History. Relations between an established German literature and its competing cultural centers; classical and popular cultures, literary conventions, and nonliterary discourses (religious, national, scientific), the construction of Austrian and Swiss traditions. Instructor: Staff. 3 units.

304. Topics in Genre Theory. The construction of German literature through generic frameworks: Minnesang, epic, baroque lyric and drama, classical ballad, folksong, Bildungsroman, expressionist film, others. Instructor: Staff. 3 units.

305. Foreign Language Pedagogy: Theories and Practices. Overview of current research in the fields of second language acquisition and foreign language pedagogy, and its implications for the teaching of the German language, literature, and culture at all levels. Readings and discussions on competing theories of language acquisition and learning, issues of cultural identity and difference, learner styles, and the teaching of language as culture; training in contemporary teaching techniques and approaches. Instructor: Staff. 3 units.

321. Graduate Dissertation Colloquium. The course will probe the complexities of advanced research from several perspectives: the opening up or extension of a specific scholarly field; the articulation of results in a broad professional context, including publication; the translation of personal explorations into pedagogical assets. GS students will present dissertation chapters; GS faculty will give guest talks surveying their own work, its interdisciplinary implications & the goal of synthesizing research & teaching. Instructor: Rolleston. 3 units.

322. Germanic Seminar. Instructor: Staff. 3 units.

Global Health

Associate Professor of the Practice Broverman, Director, Certificate Studies; Associate Professor Woods, Director, Master of Science Program

A certificate as well as a MS degree are available in this program.

The Master of Science in Global Health (MSc-GH) is administered by the Duke Global Health Institute (DGHI) and involves many other institutes, departments, and schools. A guiding principle of the degree program is the recognition that a multidisciplinary and multi-sector approach to health is essential, as health is influenced by a multitude of factors, including, but not limited to: individual behaviors; family and childhood dynamics; community characteristics; economic status; gender; genetics; country laws and politics; the environment; and the availability, accessibility, and quality of education, health care, nutrition, water, housing, and other basic goods.

Program Requirements

The 32-unit curriculum includes five core courses, one elective from each of four thematic blocks, a field experience to apply learned research methods, and a research-based scholarly thesis. It is designed as a four-semester program (fall, spring, summer, fall), though it can be completed in three semesters (fall, spring, summer) for students who wish to intensify and accelerate their studies.

The five core courses are:
- 310. Global Health Challenges
- 320. Research Methods in Global Health Science I
- 321. Research Methods in Global Health Science II
- 330. Bioethics
- 340. Health Systems and Health Policy

Elective courses will be offered in a variety of departments, schools, and institutes across the university. Students will select from a list of approved courses determined to meet each of four thematic blocks:
- Disease Causation and Prevention
- Global Environmental Health
- Global Health Policy and Management
- Populations Sciences
Students are also required to complete a fieldwork experience, approved by the Director of the MSc-GH program, and a research-based scholarly thesis. For more detailed course descriptions, visit our Web site at http://globalhealth.duke.edu/ or see the individual department’s listing.

CERTIFICATE in GLOBAL HEALTH

The Global Health Certificate Program is an interdisciplinary certificate that aims to provide future leaders with tools both to synthesize current knowledge in new ways and to formulate innovative solutions to achieve improvement in the quality of health for underserved populations. The program draws upon established research programs relating to global health centered in anthropology, biology, economics, history, law, medicine, philosophy, political science, psychology, public policy, religion, and sociology.

Certificate Requirements:
Student must complete the following:
• PPS 154/PPS 254/LAW 365/NURS 455.
• Global Health Ethics course (can be used to fulfill either the ethics requirement or an elective requirement).
• Global Health Capstone course (taken during spring of senior year).
• Two electives from the list of approved Global Health certificate electives.
• Internship/fieldwork experience.

For more detailed course descriptions, visit our Web site at http://globalhealth.duke.edu/education/graduate-professional/ or see the individual department’s listing.

Global Health Courses (GLHLTH)

222. Global Health Policy and Policy-Making. Introduction to essential global health policy concepts, understanding of global health policy-making, how policies affect “reality on the ground” in global health and development. Build critical analytical skills and the ability to translate coursework into broader understanding of policies and policy-making. Includes lectures, analysis, discussion, readings, case studies. Open to juniors, seniors, and Master's students pursuing GH certificate or public policy, MSc in GH, SOM third year. Department consent required. Instructor: Miller. 3 units. C-L: Public Policy Studies 281

238. Global Environmental Health: Economics and Policy. 3 units. C-L: see Environment 238; also C-L: Public Policy Studies 237

250S. Introductory Demographic Measures and Concepts. Introduction to demographic concepts, measures, and techniques. Focus on population change, mortality, morbidity, fertility, marriage, divorce, and migration. Illustration of broader application of demographic measurement and techniques to other aspects of society and population health, such as educational attainment, labor force participation, linkages between mortality, morbidity and disability, and health and mortality differentials. Students will also learn how to apply methods discussed. Instructor: Merli. 3 units. C-L: Public Policy Studies 266S

251. Global Health Ethics: Interdisciplinary Perspectives. Same as Global Health 151 but requires an additional paper; not open to students who have taken Global Health 151. Department consent required. Instructor: Whetten. 3 units. C-L: Public Policy Studies 256


279S. Special Topics in Ethics. 3 units. C-L: see Study of Ethics 280S

280. Special Topics in Global Health. Topics vary depending on semester and section. Topics may include: global health ethics, field methods, health technologies, rapid needs assessment, and global health policies. Instructor: Staff. 3 units.

280S. Special Topics in Global Health. Topics vary depending on semester and section. Topics may include: global health ethics, field methods, health technologies, rapid needs assessment, and global health policies. Instructor: Staff. 3 units.

284. Global Health Supply, Organization and Financing. 3 units. C-L: see Economics 284; also C-L: Public Policy Studies 284

295. Independant Study in Global Health. Individual non-research directed study in a field of special interest on a previously approved topic, under the supervision of a faculty member, resulting in a significant academic product. Open only by consent of instructor and director of Global Health Certificate program. Instructor: Staff. 3 units.

310. Global Health Challenges. Course introduces major global health problems and social, behavioral, economic, biomedical and environmental determinants of health in resource limited settings. Topics include communicable diseases i.e. HIV, malaria, tuberculosis and common childhood diseases; chronic diseases such as cancer, diabetes, cardiovascular disease and mental health; and determinants of health associated with these diseases, such as poverty, gender imbalance, culture, poor
environmental sanitation, malnutrition, tobacco use, and climate change. Other topics may include health promotion, reproductive health, maternal and child health, and disaster preparedness. Departmental consent required. Instructor: Woods. 3 units.

320. Global Health Research: Introduction to Epidemiologic Methods. Introduces principles of epidemiology, including disease frequency measures; measures of association; observational, experimental, and quasi-experimental study designs; validity -- confounding, selection bias, measurement error; reliability. The course also will interweave introductory biostatistics for continuous and categorical variables. Lab section in which students walk through guided data analysis on provided data set using STATA. Instructor: Pence. 4 units.

321. Global Health Research: Design and Practice. Course introduces wide range of methodologies appropriate for global health research and will cover the advantages and disadvantages of each. Students develop ability to evaluate and use best methodological approach to answer their research question, Team projects and appropriate technologies also examined. Students further refine skills in designing a research project and will be taught how to design qualitative and quantitative surveys, in-depth interviews, and conduct ethnographies. Instructor: Read. 3 units.

330. Bioethics. Course presents overview of practical and theoretical approaches to bioethics from a range of perspectives, including humanities, law, philosophy, medicine and science. Students apply various resources, terminology and frameworks to case studies, preparing them for their own research. Course includes IRB and responsible conduct of research. Instructor: McKinney and Sreenivasan. 1 unit.

340. Health Systems in Developing Countries. Course introduces key challenges faced in strengthening of health systems in low and middle income countries. Topics include: overview of organization of health systems, models of purchasing and providing health care, innovations in financing health care, issues in service delivery such as quality of care and human resource challenges, and frameworks and methods employed in the evaluation of health systems. Course will also draw attention to resource allocation problems and various frameworks used to address them. Readings primarily from health policy, economics and other social science journals. Consent of instructor required. Instructor: Mohanan. 3 units.

381. Ungraded Research in Global Health. Individual research in a field of special interest, the central goal of which is a substantive paper containing significant analysis and interpretation of a previously approved topic. Consent required. Instructor: Staff. Variable credit.

390. Special Topics in Global Health. Topics vary depending on semester and section. Topics may include: global health ethics, field methods, health technologies, rapid needs assessment, and global health policies. Topics course. Instructor: Staff. 3 units.

391. Independent Study in Global Health. Individual non-research directed study in a field of special interest on a previously approved topic, under the supervision of a faculty member, resulting in a significant academic product. By consent of instructor and DGS. Instructor: Staff. 3 units.

Graduate Liberal Studies

See listing under “Liberal Studies” on page 158.

Graduate Studies

Graduate Studies Courses (GS)

300. Colloquium on the Academic Profession. This course is designed to explore faculty roles and responsibilities at various types of colleges and universities. It will bring together faculty from schools in the Triad and Triangle area to discuss such topics as: how teaching is evaluated and weighed at different institutions; what counts as service; what are different schools looking for in new faculty appointments; how can you maintain a research career in a school whose priorities are undergraduate teaching; what makes a good mentor; departmental politics. The course is restricted to Preparing Future Faculty Fellows and will meet monthly on the campuses of Durham Technical Community College, Duke, Elon College, Guilford College, and Meredith College. Instructor: James. 1 unit.

301. College Teaching and Visual Communication. Visual communication for teaching and other professionals in print, in face-to-face situations and online. Includes intro to web design, intro to graphic design, effective presentations, development of an electronic teaching portfolio and exploration of other instructional technology for college teaching. Instructor consent required. Instructor: Crumley. 1 unit.

302. Introduction to College Teaching. Classroom teaching skills, like research and writing skills, require time and effort to learn and develop. In this six-part workshop series, you will learn principles and strategies for effective college teaching. Topics include: (1) Planning and designing an effective course, (2) Reflecting on beliefs about students and learning, (3) Writing the syllabus and learning objectives, (4) Selecting teaching methods and learning activities, (5) Evaluating teaching and learning, and (6) Integrating teaching and learning. The series is offered several times each semester. Instructor: James. 1 unit.

Instructor: Staff. 3 units.

Developing students’ academic discussions, argumentation, and presentation skills. Discussion and videotaped academic presentations in various genres. Addresses cultural expectations affecting successful cross-cultural communication; units on practicing the basic writing skills and text forms of graduate-level writing. Emphasis on making claims and developing supporting argumentation. Also addresses basic organizational patterns, academic grammar, recognizing and avoiding plagiarism, appropriate paraphrasing and source citation, proofreading skills, techniques for academic vocabulary acquisition. Individual conferences with students to provide feedback, training and guidance. Instructor: Staff. 3 units.

311. Responsible Conduct of Research: Graduate Forums. Beyond orientation training, Ph.D. students must earn six additional credits of RCR training during their first three years of study. The Graduate and Medical Schools offer a series of RCR forums (two credits each) during the academic year. Topics include copyright and fair use laws, proper use of data, research with human or animal subjects, authorship, and mentoring. Other RCR training when pre-approved by the Graduate School may take a variety of formats including graduate courses, departmental seminars, or workshops. Instructor: Staff. Variable credit.

312. Responsible Conduct of Research: Departmental Forum. Beyond RCR training, Orientation training, Ph.D. students must earn 6 additional credits of RCR training during their first three years of study. Departments, programs, or research centers can propose and offer more discipline-specific training for credit when pre-approved by the Associate Dean. Topics vary widely, but should relate to the Graduate School's RCR topics (academic integrity, conflict of interest, mentor/advisee roles, human or animal subjects, proper use of data, fiscal or social responsibility), and to ethical issues encountered when conducting research in the discipline. Variable credit.

320A. Academic Writing for Graduate Students I. For non-native speakers. Focus on developing awareness of and practicing the basic writing skills and text forms of graduate-level writing. Emphasis on making claims and developing supporting argumentation. Also addresses basic organizational patterns, academic grammar, recognizing and avoiding plagiarism, appropriate paraphrasing and source citation, proofreading skills, techniques for academic vocabulary acquisition. Individual conferences with students to provide feedback, training and guidance. Instructor: Staff. 3 units.

320B. Academic Communication and Presentation Skills for International Students. For non-native speakers. Focus on the developing oral communication skills and text forms of academic writing: discipline-specific texts in various genres, including research paper introductions, abstracts, graphs and charts, summaries, critiques, and literature reviews. Techniques for academic vocabulary acquisitions, retention, and retrieval. Extensive writing practice and intensive instructor feedback over multiple revisions of assignments. Individual conferences and revisions of writing exercises to provide personalized guidance. Instructor: Staff. 3 units.

321A. Academic Writing for Graduate Students II. For non-native speakers. Focus on more advanced skills and text forms of academic writing: discipline-specific texts in various genres, including research paper introductions, abstracts, graphs and charts, summaries, critiques, and literature reviews. Techniques for academic vocabulary acquisitions, retention, and retrieval. Extensive writing practice and intensive instructor feedback over multiple revisions of assignments. Individual conferences and revisions of writing exercises to provide personalized guidance. Instructor: Staff. 3 units.

321B. Academic Communication and Presentation Skills for International Students. For non-native speakers. Focus on developing students' academic discussions, argumentation, and presentation skills. Discussion and videotaped academic presentations in various genres. Addresses cultural expectations affecting successful cross-cultural communication; units on improving pronunciation and fluency incorporated throughout. Individual conferences, and peer review throughout course. Instructor: Staff. 3 units.

Health Policy

Kathryn Whetten, PhD, Faculty Director

A certificate is available in this program.

The Center for Health Policy, based at Duke University’s Global Health Institute, offers an interdisciplinary certificate in health policy for graduate students. Courses in the health policy certificate program address three interrelated goals: (1) to investigate the machinery of contemporary health policy-making and to understand the broad political dynamics that have conditioned U.S. health policy, past and present; (2) to familiarize students with the institutional and economic complexity of the U.S. health care system through the study of the interaction between the key players in health care financing and organization—employers, private insurance carriers, government regulators, health care providers and consumers; and, (3) to explore the cultural and ideological underpinnings of modern conceptions of health and the recurrent ethical dilemmas facing health care providers, patients, and policymakers.
The program draws upon established research programs relating to health services centered in public health, economics, political science, public policy, and sociology, but recognizes the inspired contributions to health care debates originating in the disciplines of anthropology, history, law, medical arts, philosophy, psychology, and religion.

Program Requirements

The health policy certificate program is open to all graduate students. Successful candidates must complete the prescribed combination of five courses: two courses drawn from the core set of health policy offerings; any two additional elective courses; and the capstone course. Appropriate courses may come from the representative list below or may include other courses (new courses, special topics courses, independent study, and, under special circumstances, courses offered through the UNC School of Global Public Health) as approved by the director.

Requirements:

- Must complete five courses including a capstone seminar (Courses must be 200-level or above.
- No limit on number of courses taken from a single department or program.):
  - Two core courses taken prior to enrolling in capstone seminar. See list of approved courses.
  - Two elective courses. See list of approved courses.
  - Capstone course HLTHPOL 255: Health Policy Analysis/cross-listed as PUBPOL 255.

The program is open to all Duke graduate, degree-seeking students, DU Continuing Studies, and inter-institutional graduate students at UNC, NCSU, or NCCU. For further information, visit the Program Web site at: http://www.globalhealth.duke.edu/chp/.

Health Policy (HTHPOL)

295. Topics in Health Policy. Topics vary by semester. Instructor: Staff. 3 units.

RELATED COURSES FROM OTHER DEPARTMENTS

Capstone Course (required)
Health Policy 255. Health Policy Analysis. Topics vary by semester. Instructor: Staff. 3 units.

Core Courses (any 2 courses)

Regularly Scheduled Courses
Economics 215S. Applied Cost Benefit Analysis. Prerequisite: Economics 149
Economics 356. Graduate Health Economics 1. Prerequisites: Economics 243 and 301
Economics 357. Seminar in Health Economics. Prerequisites: Economics 243 and 301
Health Management 326. Fundamentals of Health Care Markets
Law 347. Health Care Law and Policy
Managerial Economics 408. Health Care Systems
Public Policy Studies 253/Political Science 249. The Politics of Health Care
Public Policy Studies 263S. Public Health Research Methods and Issues
Public Policy Studies 264S.07. Getting Value for Money in Health Care: Rationing in Theory and Practice

Elective Courses (any 2 courses)**

African and African American Studies 299S.01/Psychology 262S. Minority Mental Health
African and African American Studies 299S.01/History 299S.05. Race/Medicine: Historical Perspective
Biometry 217. Clinical Decision Analysis. Prerequisite: BTP 211
Community and Family Medicine 247B. Medicine in America
Community and Family Medicine 256C. Ethical Issues in Medicine
Christian Ethics 266. Ethics and Health Care
Economics 372. Advanced Theory of Environmental and Natural Resource Economics
Environment 270. Resource and Environmental Economics. Prerequisite: introductory course in microeconomics
Environment 271. Economic Analysis of Resource and Environmental Policies. Prerequisite 270 or equivalent. Economics 149 recommended
Environment 274. Resource and Environmental Policy. Prerequisite: Environment 251 or equivalent
Environment 343. Hazard Management, Law and Ethics. Consent of instructor required
Environment 385. Decision Theory and Risk Analysis. Prerequisite: Environment 251 or equivalent
History 279. Health, Healing and History
Interdisciplinary Course 300C/Law 580. Interdisciplinary Seminar in Medical-Legal-Ethical Issues
Interdisciplinary Course 302C. Exploring Medicine: Cross-Cultural Challenges to Medicine in the Twenty-First Century
Law 235. Environmental Law

* Subject to regulations governing interinstitutional registration. Note that the School of Public Health semesters and daily schedules differ from those of Arts and Sciences. Interested students should check with the Law School to find exact course times.
** Candidates for the Master’s of Public Policy degree or Program for International Development seeking the certificate need only complete one elective course if they write their master’s memo on some aspect of health policy.
The Department of History offers graduate work leading to the AM and PhD degrees.

Candidates for the AM degree must have a reading knowledge of at least one ancient or modern foreign language related to their programs of study and have completed successfully a substantial research paper, or two seminar papers, normally the product of a year’s seminar or two semester courses. The paper(s) must be examined and approved (at a required AM meeting) by three readers: the supervising professor and two other professors from the graduate staff.

Candidates for the degree of Doctor of Philosophy prepare themselves for examinations in three or four fields, at least three of which shall be in history. The choice of fields is determined in consultation with the student’s supervisor and the director of graduate studies. The department offers graduate instruction in the broad historical areas of North America; Latin America; Great Britain and the Commonwealth; ancient, medieval, and Renaissance Europe; modern Europe; Russia; Japan; China; South Asia; military; history of science, technology, and medicine; and in the comparative and thematic fields of women's history, environmental history, diplomatic history, labor history, and slave societies.

The candidate for the PhD degree must demonstrate a reading knowledge of one foreign language, ancient or modern, prior to the preliminary examination. All students are expected to take History 301, 302, 303, and 304. In addition, each student must fulfill a general methodology requirement by completing at least one course that would appreciably increase the candidate’s methodological proficiency. With the approval of the director of graduate studies, options include taking a graduate class in methodology, such as demography, statistics, oral history, archaeology, cartography, or a summer training program for developing specific methodological skills. Students who need to master a second foreign language may substitute that language for the methodology requirements.

For courses in ancient history that may be taken for credit in either history or classical studies, see “CLASSICAL STUDIES (CLST)” on page 64.

Students may receive credit for either semester of a hyphenated course at the 200-level without taking the other semester if they obtain written consent from the instructor.

History Courses (HISTORY)

201S. The Russian Intelligentsia and the Origins of the Revolution. Origin and dynamics of the Russian revolutionary movement, the intelligentsia, and the emergence of the labor movement. Instructor: M. Miller. 3 units. C-L: Russian 218S
204S. Post War Europe, 1945-1968: Politics, Society and Culture. Politics, society and culture in Western Europe during the postwar years focusing on Cold War culture, liberalism and intellectual life. East and West during the Cold War: A comparative examination of Western European societies' and movements' responses to communism, highlighting debates on the morality of socialism and capitalism and on liberty, historical determinism, and individual responsibility. Examination of the anxieties and hopes evoked by postwar technological and economic progress - by "Americanization" and the "Economic Miracle." Instructor: Hacohen. 3 units. C-L: Political Science 209S

209S. Race, Class, and Gender: A Social History of Modern (1750-present) Britain. body of scholarship examined addresses the nature and transformation of social relations in Great Britain in the wake of the major watersheds of the modern period, including the world's first industrial revolution, imperial expansion, political economy and democratization, world wars, the rise and fall of the welfare state, decolonization, Commonwealth immigration, and admission into the European Union. Examines impact of theoretical influences on the academy ranging from Marxism through the Cold War, feminism and anti-racism, and post structuralism to post colonialism. Instructor: Thorne. 3 units. C-L: African and African American Studies 209S

210S. Anthropology and History. 3 units. C-L: see Cultural Anthropology 207S

211S. History of Poverty in the United States. 3 units. C-L: see Study of Ethics 211S; also C-L: Public Policy Studies 270S

220S. American Grand Strategy. 3 units. C-L: see Political Science 219S; also C-L: Public Policy Studies 219S

221BS. Religion and Society in the Age of the Reformation. The social history of religion in the age of the Protestant Reformation and Catholic Renewal; ritual and community in the fifteenth century; the Protestant Reformation and social change; the urban reformation in Germany and Switzerland; women and reform; Protestant and Catholic marriage, household and kinship; Catholic renewal; the formation of religious confessional identities; religion and violence; interpreting "popular" religious culture; and witchcraft. Instructor: Robisheaux. 3 units. C-L: Medieval and Renaissance Studies 220BS

222A. Maritime Predation and European Imperial Expansion in the Atlantic Basin, 1492-1730. Exploration of the origins, development, and decline of privateering and piracy as systems of maritime predation in the Atlantic basin during the period 1492-1730, building on related processes in the Mediterranean. Includes extensive study of Atlantic maritime history broadly defined. Instructor: Gaspar. 3 units.

228S. Twentieth Century Social Movements in America. Focus on the emergence of the women's movement and the civil rights movement, both concerned with issues of equality and justice, in the United States during the post-New Deal period. Instructor: Chafe. 3 units.

233AS. Narrative, History, and Historical Fiction. Examines alternative approaches to the reading and writing of history, particularly the use of narrative. Explores the power of narrative on the human imagination. Explores issues of writing "responsible" narrative history/historical fiction. Class reads and discusses selected works of historical fiction and narrative non-fiction. Combines theoretical overview with workshop format. The major project is to write a substantial piece of narrative history or historical fiction. Instructor: Partner. 3 units.

241S. Historical and Philosophical Perspectives on Science. 3 units. C-L: see Philosophy 241S; also C-L: Literature 241S, Cultural Anthropology 241S, Women's Studies 241S

255AS. Courts, Wars, Legacies of Wars (A). 3 units. C-L: see Political Science 238S

256. Modern Literature and History. 3 units. C-L: see French 256; also C-L: International Comparative Studies 280B

259. Archaic Greece. 3 units. C-L: see Classical Studies 221

262S. Japan Since 1945. Issues relating to post-War Japan. Topics include: the Occupation; democracy in postwar Japan; the rise of mass consumption; security and the US-Japan alliance; the political system; popular culture; arts and literature; the transformation of the countryside; the creation of an economic superpower; the myth of the kaisha; moments of conflict and crisis. Instructor: Partner. 3 units.

263. The Roman Republic. 3 units. C-L: see Classical Studies 224

264. The Roman Empire. 3 units. C-L: see Classical Studies 225

272S. Fin-de-siècle and Interwar Vienna: Politics, Society, and Culture. Advanced undergraduate and graduate colloquium and research seminar focusing on the cultural milieu of fin-de-siècle and interwar Vienna. Readings in the Austro-Marxists, the Austrian School of Economics, Freud, Kraus, the Logical Positivists, Musil, Popper, and Wittgenstein. Monographs on the Habsburg Empire, Fin-de-siècle culture and technology, Viennese feminism, Austrian socialism, philosophy of science, literature and ethics, and the culture of the Central European émigrés. Instructor: Hacohen. 3 units. C-L: German 272S

287BS. Ethnohistory of Latin America. 3 units. C-L: see Cultural Anthropology 287S; also C-L: Literature 287BS


296S. United States Policy in the Middle East. 3 units. C-L: see Public Policy Studies 257S

297S. Teaching Race, Teaching Gender. 3 units. C-L: see African and African American Studies 297S; also C-L: Women's Studies 297S, Literature 225S

299S. Special Topics. Seminars in advanced topics, designed for seniors and graduate students. Some semesters open to
seniors and graduate students; some semesters limited to graduate students only. Instructor: Staff. 3 units.

**Required Courses for Graduate Students**

301. Readings in Law and Society. A required course that focuses on the history and historiography of various aspects of Law and Society. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

302. Latin American History. This seminar is required of all entering first-year doctoral candidates in history. Instructor: Staff. 3 units.

303S. Focusing on Teaching and Pedagogy. A required course that focuses on a range of pedagogical issues, both to support student's work in the classroom as teaching assistants and to prepare them for teaching in their professional careers. Course work will culminate in the creation of a teaching portfolio. Consent of instructor required. Instructor: Staff. 3 units.

304. Focusing on Preparing Portfolios for Preliminary Certification. A required course, though ungraded, supporting students, most commonly in the third year, as they prepare portfolios for preliminary certification. Instructor: Staff. 3 units.

**Colloquia and Seminars for Graduate Students**

305S. Readings in Global Connections. A continuation of History 210S/Cultural Anthropology 207S. Recent scholarship that combines anthropology and history, including culture history, ethnology, the study of mental life, structural history, and cultural biography. The value of the concept of culture to history and the concepts of duration and event for anthropology. Prerequisite: History 201S or Cultural Anthropology 207S. Instructor: Staff. 3 units. C-L: Cultural Anthropology 305S

311. Readings in European History. The department offers a series of rotating courses, covering the history and historiography of various aspects of European History. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

312. Readings in Latin American History. The department offers a series of rotating courses, covering the history and historiography of various aspects of Latin American History. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

313. Readings in African and Asian History. The department offers a series of rotating courses, covering the history and historiography of various aspects of African and Asian History. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

315. Readings in Global Connections. The department offers a series of rotating courses, covering the history and historiography of various aspects of Global Connections. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

320. Readings in Law and Society. The department offers a series of rotating courses, covering the history of various aspects of Law and Society. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

325S. Readings in Politics, Public Life, The State. The department offers a series of rotating courses, covering the history and historiography of various aspects of Politics, Public Life, The State. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

335S. Readings in Methods, Theory. The department offers a series of rotating courses, covering the history and historiography of various aspects of Methods, Theory. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

337S. Readings in Cultural History. Students read representative classics in cultural history, explore the theoretical foundations and assumptions of the works studied, unpack the various meanings of the term “culture,” and analyze shifts in the field from the nineteenth century to the present. Instructor: Martin. 3 units.

340. Readings in Racial Formations. The department offers a series of rotating courses, covering the history and historiography of various aspects of Racial Formations. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.


345. Readings in Empires, Colonial Encounters. The department offers a series of rotating courses, covering the history and historiography of various aspects of Empires, Colonial Encounters. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

345A. Spaces, Bodies, & Narratives: Mapping Religion in Colonial India. 3 units. C-L: see Religion 368

350. Readings in Labor Systems, Capitalism, Business Cultures. The department offers a series of rotating courses, covering the history and historiography of various aspects of Labor Systems, Capitalism, Business Cultures. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

351. Colloquia. Each colloquium deals with an aspect of history by means of readings, oral and written reports, and discussion, with attention to bibliography. Ad hoc colloquia may be worked out during registration in the various fields represented by
members of the graduate faculty; these colloquia do not appear on the official schedule of courses. In some instances, students may take the equivalent of a research seminar in conjunction with the colloquium and will be credited with an additional 6 units by registering for 371.1-372.1, etc. Instructor: Staff. Variable credit.

359. Readings in Military History, Science, Technology. The department offers a series of rotating courses, covering the history and historiography of various aspects of Military, Science, Technology. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Instructor: Staff. 3 units.

360. Research in North American History. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in North American History, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

361S. Research in European History. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in European History, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

362. Research in Latin American History. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Latin American History, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

363. Research in African and Asian History. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in African and Asian History, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

365. Research in Global Connections. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Global Connections, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

368S. Research in Law and Society. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Law and Society, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

371. Research in Politics, Public Life, The State. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Politics, Public Life, The State, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

372S. Research in Gender. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Gender, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

374S. Research in Methods, Theory. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Methods, Theory, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

376S. Research in Racial Formations. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Racial Formations, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

377S. Research Seminar in Cultural History. Students develop a research project in cultural history. Common readings include a series of methodological works in history, literary theory, and cultural anthropology. The focus of the class is the student's independent work that is to result in a research paper the equivalent in scope and length of a research based journal article. Instructor: Martin. 0 units.

378. Research in Empires, Colonial Encounters. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Research in Empires, Colonial Encounters, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

380. Research in Labor Systems, Capitalism, Business Cultures. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Labor Systems, Capitalism, Business Cultures, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.
382. Research in Military History, Science, Technology. The department offers a series of rotating courses that offer students the opportunity to research and write on topics in Military History, Science, Technology, with the expectation that students will produce a substantial term paper based on research in primary sources. Specific topics vary, as do the instructors. Instructor: Staff. 3 units.

398. Special Reading Topics, Independent Study. These courses allow for independent study on specific topics on an individual basis with instructors. Written work is confined to methodological, conceptual, or historiographic essays. Consent of instructor required. Instructor: Staff. 3 units.

399. Special Reading Topics, Independent Study. These courses allow for independent study on specific topics, on an individual basis with instructors. The expectation is that students will produce a substantial term paper based on research in primary sources. Consent of instructor required. Instructor: Staff. 3 units.

History and Philosophy of Science, Technology, and Medicine
Associate Professor, Janiak, Director of Graduate Studies

A certificate is available in this program.

The History and Philosophy of Science, Technology, and Medicine (HPSTM) is an interdisciplinary graduate certificate program at Duke University designed to complement and enrich the curricula of graduate students studying history, philosophy, science, engineering, medicine, or other disciplines. The program is administered by the History and Philosophy Departments, but is wide-ranging and draws participants from Evolutionary Anthropology, Biology, Civil and Environmental Engineering, Classical Studies, Cultural Anthropology, Economics, English, Germanic Languages and Literature, Literature, Psychology and Brain Sciences, Religion, Womens Studies, and other Duke departments and programs.

Requirements:
• Requires the HPSTM core graduate seminar taught annually as a cross-listed course in History and Philosophy (PHL 241/HIS 241).
• One elective seminar or directed readings course in the history of science, technology or medicine.
• One elective seminar or directed readings course in the philosophy of science or the history of the philosophy of science.
• One elective seminar or directed readings course relevant to the students HPSTM interests.
• Capstone research paper on a HPSTM-related topic.

For more information visit http://philosophy.duke.edu/hpstm/.

Humanities, Master of Arts Program in
Professor Bell, Director

The Master of Arts Program in Humanities is an interdepartmental program tailored to the needs of individual students. The candidate defines a theme and selects appropriate course work with the aid and approval of an academic advisor. Thirty units of course work are required for completion of the program. The degree may be earned with or without a thesis. The candidate who chooses not to submit a thesis will submit instead at least two substantial papers arising from course work for review by committee members, and will meet with them to discuss his or her program in a final master’s colloquium.

The program is open to holders of undergraduate degrees in any discipline who can demonstrate sufficient background in humanities to permit study at the graduate level. Admission is by regular application to the Graduate School. Students may enroll full time or part time. The program also participates in the general set of joint JD/MA programs offered at Duke. This allows law students to develop and broaden a complementary field of interest—women’s studies, for example, or contemporary literature and hermeneutic theory—to maintain an intellectual focus already developed in their undergraduate careers.

Immunology
Professor Krangel, Interim Chair (318 Jones); Associate Professor Zhuang, Director of Graduate Studies (328 Jones); Professors Abraham, Buckley, Burks, Chao, Coffman, Cousins, Frank, Hall, Haynes, Hoffman, Kelsoe, Kepler, Krangel, Lyerly, Pitsketsky, St.Clair, Tedder, Weinberg, Weinhold; Associate Professors Clay, Gunn, He, Kondo, Markert, Rathmell, Staats, Szabolcs, Yang, Zhang, Zhuang; Assistant Professors Cowell, Hollingsworth, Li, Lin, Sampson, Shinohara, Taylor, Tomaras, Unniraman, Zhong; Associate Research Professor Sarzotti-Kelsoe; Assistant Research Professors Poe, Williams, Zhu; Adjunct Professor Barker; Adjunct Assistant Professors Cook, Demarest, Gray, Haas, Sarafova

The Department of Immunology offers graduate work leading to the PhD degree.

Immunology is the study of the cells, proteins, and genes that protect against infection and malignancy. Immunology encompasses innate and natural, nonspecific defense mechanisms, as well as specific immune responses that generate immunologic memory. The department’s focus is on lymphocytes, and their cellular biology, physiology,
Immunology Courses (IMMUNOL)

201. Laboratory Rotation. Laboratory rotation for first year Immunology graduate students, first semester. Department consent required. Instructor: Staff. 1 unit.

202. Laboratory Rotation. Laboratory rotation for first year Immunology graduate students, second semester. Department consent required. Instructor: Staff. 1 unit.

213S. Computational Immunology. 3 units. C-L: see Computational Biology and Bioinformatics 223

244. Principles of Immunology. An introduction to the molecular and cellular basis of the immune response. Topics include anatomy of the lymphoid system, lymphocyte biology, antigen-antibody interactions, humoral and cellular effector mechanisms, and control of immune responses. Prerequisites: Biology 119 and Chemistry 151L or equivalents. Instructors: He and Zhang. 3 units. C-L: Biology 244

258. Structural Biochemistry I. 2 units. C-L: see Biochemistry 258; also C-L: Cell and Molecular Biology 258, Cell Biology 258, University Program in Genetics 258, Structural Biology and Biophysics 258, Computational Biology and Bioinformatics 258

259. Structural Biochemistry II. 2 units. C-L: see Biochemistry 259; also C-L: Cell Biology 259, Computational Biology and Bioinformatics 259, Structural Biology and Biophysics 259, University Program in Genetics 259

268. Biochemical Genetics II: From RNA to Protein. 2 units. C-L: see Biochemistry 268; also C-L: Cell Biology 268, University Program in Genetics 268

291. Comprehensive Immunology. An intensive course in the biology of the immune system and the structure and function of its component parts. Major topics discussed are: properties of antigens; specificity of antibody molecules and their biologic functions; cells and organs of the lymphoid system; structure and function of complement; inflammation and nonspecific effector mechanisms; cellular interactions and soluble mediators in lymphocyte activation, replication, and differentiation; regulation of immune responses; molecular structure and genetic organization of immunoglobulins, histocompatibility antigens, and T-cell receptor. Required course for all students specializing in immunology. Consent of instructor required. Prerequisite: recommended, Immunology 244 or equivalent. Instructor: Zhuang and staff. 3 units.

300. Tumor Immunology. An advanced seminar based on original literature focusing on neoplasia and the immune system. Topics include a general introduction to malignancy and immune responses associated with them, regulation of the immune response to tumor, vaccine development, the role of gene therapy, the use of tumor-reactive monoclonal antibodies, and strategies for subversion of immune responses and immunopathology. Offered biennially (in rotation with IMM 310). Prerequisite: Immunology 291. Instructor: Tedder and Yang. 2 units.

310. Immunopathogenesis. Intended for basic scientists and physicians. Advanced study of immune-mechanisms central to human disease including localized and systemic autoimmunity, transplantation tolerance, allergy and asthma, and immunodeficiency syndromes. Lectures detail cellular- and molecular immune mechanisms that effect specific pathologies. Offered biennially (in rotation with IMM 300). Prerequisites: IMM 244, IMM 291, or equivalents. Consent of instructor required. Instructor: St. Clair and Kelsoe. 3 units.

320. Immunology of Infectious Diseases. This course will cover the immune aspect of host-pathogen interaction at both the molecular and cellular levels. Topics include innate immune responses to pathogens such as pattern recognition receptors and effector mechanisms of innate immunity, adaptive immune responses to bacterial, viral and fungal infections, pathogenic strategies for subversion of immune responses and immunopathology, vaccine development to emerging and re-emerging infectious disease. The current understanding of host immune responses to specific pathogens including HIV, HBV, HVC, Malaria, and Mycobacterium tuberculosis will be discussed. Prerequisites: IMM244. Instructor: He and staff. 2 units. 2 units.

331. Immunology Seminar. Work in progress seminar in which students and postdoctoral trainees give 30 min to 1 hour presentations of their research. Considered a showcase of current research in the Department of Immunology. All students enrolled in IMM programs are required to give a presentation once per year. Informal questions and discussion are encouraged throughout presentation. First and second year Immunology graduate students should register for IMM 331 which is graded credit. Third through sixth year Immunology students, along with non-Immunology majors should register for IMM 332 which
is non-graded credit. Attendance is essential for both spring and fall terms. Permission of instructor is required. Instructor: Kondo. 1 unit.

332. Immunology Seminar. Work in progress seminar in which students and postdoctoral trainees give 30min to 1 hour presentations of their research. Considered a showcase of current research in the Department of Immunology. All students enrolled in IMM programs are required to give a presentation once per year. Informal questions and discussion are encouraged throughout presentation. First and second year Immunology graduate students should register for IMM 331 for graded credit. Third through sixth year Immunology students, along with non-Immunology majors should register for IMM 332 which is non-graded credit. Attendance is essential for both spring and fall terms. Permission of instructor is required. Instructor: Kondo. 1 unit.

335. Topics in Immunology. Focus on current immunology research, emphasizing emerging research areas and new directions in established areas. Students present recent papers in selected subjects. This course is required for all Immunology graduate students starting the second semester of their first year. Credit/no credit grading only. Permission is required by instructor. Instructor: Kondo. 1 unit.

336. Topics in Immunology. Focus on current immunology research, emphasizing emerging research areas and new directions in establishment areas. Students present recent papers in selected subjects. This course is required for all Immunology graduate students starting the second semester of their first year. Credit/No Credit grading only. Permission is required by instructor. Instructor: Kondo. 1 unit.

Information Sciences and Information Studies
Professor Lenor, Director of Graduate Studies

A certificate is available in this program.

The purpose of the ISIS Graduate Certificate is to offer an interdisciplinary program at the graduate level that focuses on the study and creation of new information technologies and the analysis of their impact on art, culture, science, medicine, commerce, society, and the environment. The program is designed for doctoral students wishing to complement their primary disciplinary focus with an interdisciplinary certificate in Information Science and Information Studies. The goal of the certificate is to broaden the scope of the typical disciplinary PhD program and to engage the student in ISIS-related research. The ISIS Graduate Certificate is not intended to provide a disciplinary canon in information science and information studies but rather to develop a structured set of transdisciplinary skills and resources for exploring new areas of academic research. As such, the ISIS Graduate Certificate is not to lead students down an existing path of traditional academic research but rather to provide them with the means for expanding the scope of their main disciplinary focus by creating new paths of their own.

Requirements:

• Complete ISIS 250S Critical Studies in New Media.

• Three courses from the approved elective course list (from at least two different departments).

• One formal presentation to the ISIS Graduate Research Forum, coordinated through the ISIS director of graduate studies and documented via online website and presentation archive.

• Participation in at least four ISIS Graduate Research Forums (or related events) to be tracked by the ISIS director of graduate studies and program coordinator through student sign-up sheets.

For more information visit [http://isis.duke.edu/](http://isis.duke.edu/) or contact the Director of Information Science and Information Studies at Duke University, Box 90400, 2204 Erwin Road, Durham, NC 27708-0400. Phone: (919) 668-1934. E-mail: isis-info@duke.edu

Information Science and Information Studies Courses (ISIS)

207. New Media, Memory and the Visual Archive. 3 units. C-L: see Visual Studies 270S

225S. Chinese Media and Pop Culture. 3 units. C-L: see Asian & Middle Eastern Studies 250S

240S. Technology and New Media: Academic Practice. How information technology and new media transform knowledge production in academic practice through hands-on work. Critique of emergent digital culture as it impacts higher education; assessing impact of integrating such tools into scholarly work and pedagogical practice. Modular instruction with guest specialists assisting with information technology tools and media authorship theory. Topics may include: web development, information visualization, time-based media, databases, animations, virtual worlds and others. Theoretical readings; hands-on collaboration; ongoing application to individual student projects. Knowledge of basic web development, personal computer access recommended. Instructor: Szabo. 3 units. C-L: Art History 240S, Visual Studies 250BS

250S. Critical Studies in New Media. New media technologies examined from a transdisciplinary perspective; how they compare with, transform, and remediate previous media practices. Instructor: Lenor. 3 units. C-L: Literature 261S, Art History 250S, Visual Studies 250AS

260S. Information Archeology: Studies in the Nature of Information and Artifact in the Digital Environment. Interdisciplinary exploration of the nature of artifact and evidence, information and knowledge embedded in structured and
Theoretical and practical bases for research and teaching in toxicology. This interdepartmental program brings together graduate students, postdoctoral fellows, and faculty members from a variety of scientific disciplines to address toxicological and associated environmental health problems from their molecular basis to clinical and environmental consequences. The ITEHP includes participation of faculty members from the Departments of Biochemistry, Cell Biology, Chemistry, Neurobiology, Pathology, Pharmacology, and the Nicholas School of the Environment and Earth Sciences including the Duke Marine Laboratory. Among the principal areas of concentration in the program are neurotoxicology and neurological disease, epigenetics, genetic toxicology, cancer, developmental toxicology and children’s health, environmental exposure and toxicology, and pulmonary toxicology and disease. Duke faculty members have a variety of collaborative research efforts and student rotations are available with scientists at the nearby laboratories of the National Institute of Environmental Health Sciences (NIEHS), the CTI Centers for Health Research, and the Environmental Protection Agency (EPA).

Application to the program can be made in two ways. If your primary interest is Toxicology, then you may apply for admission directly through the Integrated Toxicology and Environmental Health Program, indicating "Toxicology" as your primary admitting unit on the standard graduate school application. Students admitted directly into the Integrated Toxicology and Environmental Health Program affiliate with a department depending upon their choice of research mentor. Students with a primary interest in a departmentally based field may also apply to the Integrated Toxicology and Environmental Health Program by indicating "Toxicology" as the secondary field on the graduate school application. The primary field should indicate the specific graduate department in Arts and Sciences, the School of Medicine, or the Nicholas School of the Environment and Earth Sciences. There is no difference in the

Integrated Toxicology and Environmental Health Program

Professor Kuhn, Director of Graduate Studies

This is an admitting program.

A certificate is also available in this program.

The Duke University Integrated Toxicology and Environmental Health Program (ITEHP) provides students with the theoretical and practical bases for research and teaching in toxicology. This interdepartmental program brings together graduate students, postdoctoral fellows, and faculty members from a variety of scientific disciplines to address toxicological and associated environmental health problems from their molecular basis to clinical and environmental consequences. The ITEHP includes participation of faculty members from the Departments of Biochemistry, Cell Biology, Chemistry, Neurobiology, Pathology, Pharmacology, and the Nicholas School of the Environment and Earth Sciences including the Duke Marine Laboratory. Among the principal areas of concentration in the program are neurotoxicology and neurological disease, epigenetics, genetic toxicology, cancer, developmental toxicology and children’s health, environmental exposure and toxicology, and pulmonary toxicology and disease. Duke faculty members have a variety of collaborative research efforts and student rotations are available with scientists at the nearby laboratories of the National Institute of Environmental Health Sciences (NIEHS), the CTI Centers for Health Research, and the Environmental Protection Agency (EPA).

Application to the program can be made in two ways. If your primary interest is Toxicology, then you may apply for admission directly through the Integrated Toxicology and Environmental Health Program, indicating "Toxicology" as your primary admitting unit on the standard graduate school application. Students admitted directly into the Integrated Toxicology and Environmental Health Program affiliate with a department depending upon their choice of research mentor. Students with a primary interest in a departmentally based field may also apply to the Integrated Toxicology and Environmental Health Program by indicating "Toxicology" as the secondary field on the graduate school application. The primary field should indicate the specific graduate department in Arts and Sciences, the School of Medicine, or the Nicholas School of the Environment and Earth Sciences. There is no difference in the
eventual degree granted through either mechanism; both routes result in a PhD granted by a specific department, with certification in Toxicology. It is expected that most students will have a strong undergraduate preparation in mathematics and the physical and biological sciences with demonstrated excellence of performance as judged by grades in coursework and letters of recommendation from former instructors. Each student in the program will take a series of courses in toxicology and environmental health as well as courses specified by his or her department. A student will be expected to choose a dissertation advisor in his or her department at least by the end of the first two semesters in the program and will normally be expected to begin dissertation research during the third semester in residence. Upon satisfactorily completing all degree requirements in the program and in the department, students will be jointly recommended for the PhD degree.

Students are offered admission to the program with fellowship support based on rank among all applicants. Students may be awarded a Toxicology and Environmental Health fellowship or may be accepted into the Toxicology and Environmental Health Program with support from departmental funds. For each entering year, approximately four full fellowships (tuition, fees and stipend) are awarded to Toxicology graduate school applicants. Please note that Toxicology and Environmental Health fellowships are restricted to U.S. citizens or permanent residents. Non-U.S. citizens who are interested in the Integrated Toxicology and Environmental Health Program will need to apply and request funding directly through a participating department. Applicants must have a bachelor’s degree with a strong foundation in mathematics and the biological and physical sciences. Applicants must submit scores on the GRE general test, transcripts, and letters of recommendation. It is expected that course work and research experience will vary among applicants but that the applicant’s academic credentials will be sufficient to ensure successful completion of the degree.

Certificate Requirements:
- Thesis advisor must be a member of the program.
- Two members of the student’s thesis committee (in addition to the advisor) must be members of the program.
- If admitted directly by ITEHP – complete three lab rotations in the first year of study, in two different departments.
- If admitted through another PhD program – must follow the rotation rules of that program.
- Pharmacology 233: Essentials of Pharmacology, Toxicology, and Drug Discovery.
- Pharmacology 254: Mammalian Toxicology; or Environment 212 Environmental Toxicology.
- Pharmacology 315 or Environment 315: Focused Topics in Toxicology.
- Pharmacology 333: Statistics for Basic Biomedical Scientists.
- Pharmacology 347-348: Seminar in Toxicology.
- Present a seminar on their dissertation work to the program, usually during the last year.
- Doctoral committee must be approved by the graduate school at least two months prior to preliminary exams.

Further information may be obtained from the Program Manager, Duke University, Box 90328, Durham, North Carolina, 27708; telephone (919) 613-8078; e-mail: toxicology@duke.edu or visit http://www.duke.edu/web/toxicology/.

Interdisciplinary European Studies
Professor Surin, Director (101F Science Building)

A certificate is available in this program.

Although Duke does not offer an interdisciplinary postgraduate degree in European Studies, graduate students affiliated with any Duke department or professional school are encouraged to document their specialization in the region by earning a Certificate in Interdisciplinary European Studies in conjunction with their master’s or doctoral degree.

Requirements:
- Five core courses with at least a 75% European Studies content, taken in at least three different departments.
- Two-year participation in the European Studies Graduate Student Colloquium (minimum of four graduate colloquium-sponsored activities per semester must be documented).
- Competency attained in one European language (other than English) equivalent to at least four semesters of college level study (advanced proficiency). Competency certification to be approved by the executive committee.
- Competency attained in a second European language (other than English) equivalent to at least two semesters of college level study (intermediate proficiency). Also approved by executive committee.
- Dissertation must have a significant focus on European Studies-related issues.
Faculty member from outside the student’s home department with European expertise must be appointed to his/her dissertation committee.

There are numerous European Studies-related courses that are naturally and historically embedded in the Duke curriculum. A list of approved courses is available at the Center for European Studies Web Site (http://www.jhfc.duke.edu/ces/). If there is a question as to whether the course meets the 75% European content requirement, such determination will be made by the CES Director in consultation with the Executive Committee. That the requirement for a significant focus on European Studies-related issues in dissertation work is met will be at the determination of the student's thesis advisor. The certificate will be signed by the Director of the Center for European Studies and the Dean of the Graduate School. Appropriate notation is made on the student's transcript. For any questions, contact the Center at (919) 684-6449.

**Interdisciplinary Medieval and Renaissance Studies**

Associate Professor Somerset (English), Chair and Director of Graduate Studies; Professors Aers (English), Beckwith (English, theater studies), Bland (religion), Borchart (Germanic languages and literature), Bruzelius (art and art history), Clark (religion), Clay (classical studies), DeNeef (English), Garcí-Gómez (romance studies), Greer (romance studies), Herrup (history), Hillerbrand (religion), Keefe (religion), Mahoney (philosophy), Mignolo (romance studies), Porter (English), Price (English), Quilligan (English), Rigsby (classical studies), Shatzmiller (history), Steinmetz (religion), and Wharton (art and art history); Associate Professors Bartlett (music), Brothers (romance studies), Finucci (romance studies), Keefe (religion), Neuschel (history), Longino (romance studies), Rasmussen (Germanic languages and literature), Robisheaux (history), Silverblatt (cultural anthropology), Solterer (romance studies), Somerset (English), Van Miegroet (art and art history); Assistant Professors McCarthy (music), Parker (classical studies), Schachter (romance studies), Woods (classical studies); Professors Emeriti Caserta (romance studies), Newton (classical studies), Randall (English, theater studies), Silbiger (music), Tetel (romance studies), Williams (English), and Witt (history); Adjunct Assistant Professor Keul (Germanic languages and literature).

**A certificate is available in this program.**

The Graduate Program in Medieval and Renaissance Studies is an interdisciplinary program administered by the Duke University Center for Medieval and Renaissance Studies. Some fifty faculty in ten different degree-granting departments participate in the Medieval-Renaissance program, offering courses in art history, history, music, philosophy, religion, and language and literature (classical studies, English, German, and Romance languages). The Program in Medieval and Renaissance Studies seeks to promote cross-departmental and cross-institutional engagement that gives students a network of colleagues beyond their home departments.

Students may earn a formal Graduate Certificate in interdisciplinary Medieval and Renaissance Studies by meeting the following requirements: (1) complete three Medieval and Renaissance courses outside of the major department (MEDREN 300 or MEDREN 301 may count as one of these three distributional courses, and students are highly encouraged to take these cross-disciplinary seminars); (2) attend the Medieval-Renaissance Graduate Colloquium for two consecutive years; (3) present a research paper at one of several local Medieval and Renaissance workshops, colloquia, or conferences; and (4) complete a dissertation on a topic in Medieval and Renaissance studies. While students may be affiliated with the Center without having to obtain the Graduate Certificate, the certificate is a valuable complement to degrees in traditional Duke departments. Students planning to obtain the certificate should file an application with the Center for Medieval and Renaissance Studies as early in their careers as possible, but no later than the fall of their graduation year.

**Requirements:**

- Complete three MEDREN courses outside of major department (discuss with DGS and thesis advisor)
  - MEDREN 300 or 301 may count as one of these.

- Attend 12 meetings of the MEDREN Graduate Colloquium which meets three times each semester and is led by faculty or visiting lecturers.

- Present a research paper at a MEDREN workshop, colloquia, or conference at a local venue.

- Dissertation on a topic in MEDREN studies (late antiquity through 17th Century on any region, in any discipline).

For an application and more detailed information on the program and its requirements, contact our director of graduate studies and visit our Web site at http://medren.aas.duke.edu/cmrs/graduateRequirements.html.

For descriptions of cross-listed courses below, see the listings under the specified departments.

**Medieval and Renaissance Studies Courses (MEDREN)**

**200. Advanced Topics in Medieval and Renaissance Studies.** Topics may focus on fine arts, history, language and literature, or philosophy and religion. Open to seniors and graduate students; other students may need consent of instructor. Instructor: Staff. 3 units.
200S. Advanced Seminar in Medieval and Renaissance Studies. Topics may focus on fine arts, history, language and literature, or philosophy and religion. These seminar courses frequently engage interdisciplinary perspectives, historiography, and interpretation of medieval and Renaissance cultures. Open to seniors and graduate students; other students may need consent of instructor. Instructor: Staff. 3 units.

201S. Introduction to Medieval German: The Language of the German Middle Ages and Its Literature. 3 units. C-L: see German 209S

202A. Christian Thought in the Middle Ages. A survey of the history of Christian theology from St. Augustine to the young Martin Luther. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Steinmetz. 3 units.

202B. Early and Medieval Christianity. A survey of the history of Christianity from its beginnings through the fifteenth century. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Keefe and Steinmetz. 3 units.

202C. Modern European Christianity. A survey of the history of Christianity from the Reformation to the present, with emphasis on the early modern era. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Heitzenrater and Steinmetz. 3 units.

203S. Sex, Gender, and Love in Medieval German Literature. 3 units. C-L: see German 210S

204. Origen. 3 units. C-L: see Religion 204

205. The English Reformation. The religious history of England from the accession of Henry VIII to the death of Elizabeth I. Extensive readings in the English reformers from Tyndale to Hooker. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Steinmetz. 3 units.

205S. Dante Studies. 3 units. C-L: see Italian 205S

206. The Christian Mystical Tradition in the Medieval Centuries. Reading and discussion of the writings of medieval Christian mystics (in translation). Each year offers a special focus, such as: Women at Prayer; Fourteenth-Century Mystics; Spanish Mystics. Less well-known writers (Hadewijch, Birgitta of Sweden, Catherine of Genoa) as well as giants (Eckhart, Ruusbroec, Tauler, Suso, Teresa of Avila, Julian of Norwich, Catherine of Siena, and Bernard of Clairvaux) are included. Also offered as a Divinity School course, and as Religion 206. Open to juniors and seniors only. Instructor: Keefe. 3 units.

207. Readings in Historical Theology. Also offered as a Divinity School course. Open to juniors and seniors only. Prerequisites: Medieval and Renaissance Studies 202B and 202C. Instructor: Staff. 3 units.

207A. Introduction to Old English. 3 units. C-L: see English 207A

209S. Special Topics is Middle English Literature: 1100 to 1500. 3 units. C-L: see English 212S

210S. Renaissance Studies. 3 units. C-L: see Italian 210S; also C-L: Art History 210S

213S. Chaucer and His Contexts. 3 units. C-L: see English 213S

216. Augustine. 3 units. C-L: see Religion 219

218S. Medieval Philosophy. 3 units. C-L: see Philosophy 218S

220BS. Religion and Society in the Age of the Reformation. 3 units. C-L: see History 221BS

220S. Shakespeare: Special Topics. 3 units. C-L: see English 220S

221BS. Special Topics in Renaissance Prose and Poetry: 1500 to 1660. 3 units. C-L: see English 221S

222A. Music in the Middle Ages. 3 units. C-L: see Music 222

222B. Music in the Renaissance. 3 units. C-L: see Music 223

224. Music in the Baroque Era. 3 units. C-L: see Music 224

228. The Legacy of Greece and Rome. 3 units. C-L: see Classical Studies 228


234A. Early Christian Asceticism. 3 units. C-L: see Religion 234

236A. Luther and the Reformation in Germany. The theology of Martin Luther in the context of competing visions of reform. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Steinmetz. 3 units.

237S. Topics in Romanesque and Gothic Art and Architecture. 3 units. C-L: see Art History 236S

239S. Special Topics in Latin Literature of the Middle Ages and Renaissance. 3 units. C-L: see Latin 240S

240. Premodern Times. 3 units. C-L: see French 240

241. History of Netherlandish Art and Visual Culture in a European Context. 3 units. C-L: see Visual Studies 210

242. History of Netherlandish Art and Visual Culture in a European Context. 3 units. C-L: see Visual Studies 211

245. Problems in Reformation Theology. Consent of instructor required. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Steinmetz. 3 units.

245S. Art and Markets. 3 units. C-L: see Visual Studies 252AS; also C-L: Economics 244S

246. Problems in Historical Theology. Consent of instructor required. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Staff. 3 units.
247. Readings in Latin Ecclesiastical Literature. Readings in Latin of pastoral, theological, and church-disciplinary literature from the late patristic and medieval period. Also offered as a graduate Religion and Divinity School course. Open to juniors and seniors only. Prerequisite: knowledge of Latin. Instructor: Keefe. 3 units.

248S. Topics in Italian Renaissance Art. 3 units. C-L: see Art History 247S

249. Early Modern Studies. 3 units. C-L: see French 247

254. Justice, Law, and Commerce in Islam. 3 units. C-L: see Religion 254; also C-L: African and African American Studies 254

260B. History of the German Language. 3 units. C-L: see German 260; also C-L: Linguistics 260

272. The Early Medieval Church. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Keefe. 3 units.

273. The Early Medieval Church, Out of Africa: Christianity in North Africa before Islam. Selected writings of Tertullian, Cyprian, and Augustine, as well as lesser known African Fathers, on topics such as the African rite of baptism, African creeds, and African church councils. Focus on major theological, liturgical, and pastoral problems in the African church in order to gain perspective on the crucial role of the African church in the development of the church in the West. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Keefe. 3 units.

276. The Sacraments in the Patristic and Early Medieval Period. A study of the celebration and interpretation of baptism or eucharist in the church orders and texts of the early church writers. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Keefe. 3 units.

284S. Latin Palaeography. 3 units. C-L: see Latin 284S

300. Research Colloquium in Medieval and Renaissance Studies. Credit grading only. Instructor: Staff. 3 units.

301. Medieval and Renaissance Studies. Seminar on the material bases (archival documents, legal records, court records, manuscripts, material artifacts, and the like) for the study of the Middle Ages. Topics addressed include origins and accessibility, as well as questions of method and historiography. Topics vary. Consent of instructor required. Instructor: Shatzmiller. 3 units.

Latin American and Caribbean Studies

A certificate is available in this program.

The Latin American and Caribbean Studies certificate is open to MA and PhD students in any professional school at Duke. The Center for Latin American and Caribbean Studies oversees and coordinates graduate education on Latin America and the Caribbean and promotes research and dissemination of knowledge about the region. Its Council on Latin American Studies is made up of Latin Americanist faculty and staff members representing Arts and Sciences disciplines and the professional schools. In addition to fulfilling the requirements of their departments, graduate and professional students may undertake special courses of interdisciplinary study, or those offered by other departments, to broaden their knowledge of the region and to earn a Graduate Certificate in Latin American and Caribbean Studies.

Requirements:

- Six graduate courses related to Latin America and/or the Caribbean. These courses may be selected from a pre-approved course list each term.
- Language Proficiency: Students must demonstrate proficiency in Spanish, French, Portuguese, or a less commonly taught language such as Yucatec Maya, Quechua, Haitian Creole, etc.
- Approval of Thesis: Students are required to have a thesis prospectus or departmental equivalent on a Latin American or Caribbean topic approved by their advisor.

For additional information about the graduate certificate in Latin American and Caribbean Studies, contact the academic program coordinator, Box 90254, Duke University, Durham, NC 27708-0254, telephone (919) 681-3980, email: las@duke.edu.

The Center for Latin American and Caribbean Studies sponsors a speakers series that provides a forum for presentations by visiting Latin Americanists from throughout the U.S. and overseas, as well as by Duke and UNC faculty and graduate students. Each year the Center also co-sponsors a number of conferences and other special events, including the annual Latin American Labor History Conference. Moreover, the Center and the Institute for the study of the Americas at UNC-Chapel Hill sponsor the Carolina and Duke Consortium in Latin American and Caribbean Studies, which provides opportunities for collaboration with faculty and students from the University of North Carolina.

The interdisciplinary focus of the graduate program is enhanced by the numerous activities of the Consortium, which offers graduate students at Duke an array of intellectually challenging opportunities to broaden their disciplinary training. The single most important initiative of the Consortium is the sponsorship of interdisciplinary working groups that bring together faculty and graduate students from both campuses to conduct research and training in areas of central concern to Latin American and Caribbean studies. The groups focus on topics such as political economy,
the environment, and Afro-Latin American perspectives.

Since 1991 the Carolina and Duke Consortium has been designated a National Resource Center for Latin American Studies by the U.S. Department of Education. This honor is accompanied by funding for a number of program activities as well as Foreign Language and Area Studies (FLAS) Fellowships for graduate students. The Center and the consortium together administer competitions for graduate student travel grants each spring. These awards provide Duke students with the opportunity to deepen their disciplinary interests in the region through relatively brief periods of research in Latin America.

More detailed information on the various components of the Latin American and Caribbean Studies program at Duke is also available on the center's Web site: http://clacs.aas.duke.edu/.

**Latin American Studies Courses (LATAMER)**

200S. Special Topics in Latin American and Caribbean Studies. Interdisciplinary study of geographical, historical, economic, governmental, political, and cultural aspects of modern Latin America and the current issues facing the region. Specific topics will vary from year to year. For juniors, seniors and graduate students. Instructor: Staff. 3 units.

298. Introduction to Latin American Cultural Studies. A problem-oriented course, but also covering theoretical issues, integrating approaches from two or more disciplines. Topics vary from year to year. Instructor: Staff. 3 units.

299S. Special Topics in Latin American and Caribbean Culture and Society. This course covers, at a graduate level, a broad range of cultural topics in Latin American and Caribbean studies from music, art, language, film, journalism, dance, poetry, politics etc. and explores the ways in which cultural expression reflects and criticizes social, economic and political forces in the region. Different topics will be chosen each term. 3 units.

350. Colloquium. Weekly presentations on various professional and intellectual issues relating to Latin American Cultural Studies. Credit/no credit grading only. Prerequisite: enrollment in Latin American Cultural Studies certificate program. Instructor: Staff. 1 unit.

**Liberal Studies**

Donna Zapf, Director

Graduate Liberal Studies (GLS) offers a Master of Arts in Liberal Studies (MALS) degree—a flexible, interdisciplinary degree that allows individuals to pursue a variety of personal and professional educational interests across disciplinary boundaries. Students study on a part- or full-time basis and choose from an array of interdisciplinary courses developed specifically for this program. GLS offers up to seven courses in each of three academic semesters (fall, spring, and summer), including study-abroad opportunities. In addition to liberal studies courses, students may select courses from other departments of the Graduate School.

The MALS degree consists of nine courses and a final project. The final project, which may take the form of academic research, applied research, or creative work, provides the opportunity for the student to apply the knowledge and skills gained through seminars to an independent activity of the student’s design.

Graduate faculty, from throughout the university, teach GLS seminars and supervise student work.

The MALS degree is now available to medical students in their third year of study. For more information about the MD/MALS degree see the School of Medicine bulletin or contact Kathryn M. Andolsek, MD, MPH, at DUMC Box 90095, Duke University, Durham, NC 27710; (919) 668-3883; andol001@mc.duke.edu.

To request a separate publication on the Master of Arts in Liberal Studies degree, including descriptions of specific courses and other degree requirements, contact the GLS Program Assistant at Box 90095, Duke University, Durham, NC 27708; (919) 684-3222; dukemals@duke.edu. Additional information on the MALS degree is available on the GLS Web site at www.mals.duke.edu.

**Literature**

Professor Hardt, Chair; Professor Hayles, Director of Graduate Studies; Professors Aravamudan (English and literature), Chow (literature), Dainotto (Italian and literature), Hansen (literature), Hardt (literature and Italian), Hayles (English and literature), Jameson (literature and French), Khanna (English and literature), Lenoir (literature), Lentricchia (literature), Mignolo (literature and Spanish), Moi (literature and French), Mudimbe (literature), B. H. Smith (English and literature), Surin (literature and religion), Wiegman (women’s studies and literature); Associate Professors Donahue (German and literature), Lubiano (African and African American Studies and literature), Mottahedeh (literature), Viego (literature and Spanish), Willis (literature); Research Professors Dorfman (literature and Latin American studies) Garreta (literature and French), Harootunian (literature)

The interdisciplinary program leading to a PhD in Literature offers qualified students the opportunity to develop individual courses of study with a strong emphasis on interdisciplinary work, literary theory, and cultural studies, while at the same time allowing students to specialize in one or more of the national literatures. The program offers both introductory courses (the 250 series) and more specialized seminars (The 280 series), as well as tutorials (300) in specific research projects or problems.

For tutorials, advising, and dissertation supervision the program draws also on the expertise of other faculty such as Professors Baucom, Davidson, Moses, Pfau, Torgovnick (English); Abe, Stiles, and Wharton (art history); Burian
and Davis (classical studies); Cooke (Asian and Middle Eastern studies); and Flanagan (philosophy).

Students entering the program are strongly advised to have reading knowledge of one language other than English upon entering the program and to acquire reading competence in a second language before taking their preliminary examinations. Students in the literature program are expected to take a minimum of twelve courses, seven of which must be in literature and five in a "teaching field" of their choice. More information on the program and a full descriptive brochure is available online at http://literature.aas.duke.edu/grad/.

Literature Courses (LIT)

200S. Seminar in Asian and Middle Eastern Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 200S; also C-L: African and African American Studies 200S, Cultural Anthropology 288S

210S. Basic Concepts in Cinema Studies. Review of theory, methodology, and debates in study of film under three rubrics: mode of production or industry; apparatus or technologies of cinematic experience; text or the network of filmic systems (narrative, image, sound). Key concepts and their genealogies with the field: gaze theory, apparatus theory, suture, indexicality, color, continuity. Instructor: Mottahehdeh. 3 units.

211S. Theory and Practice of Literary Translation. Linguistic foundations, historical roles, contemporary cultural and political functions of literary translation. Readings in translation theory, practical exercises and translation assignments leading to a translation project. Instructor: Burian. 3 units. C-L: German 211S

212S. Film Feminisms. Philosophical debates and approaches to the female form in film theory and history. Phenomenology, cultural studies, Marxism, psychoanalysis, structuralism, post-structuralism, as well as gaze theory, apparatus theory, and feminist film theory as they approach readings of the body, subjectivity and identity in cinema. Questions of spectatorship and the gendered subject. Screening and discussion of Hollywood and European avant garde films key to early debates, and of international films central to debates around the gendered subject and representation in modernity. Interrogation of feminist approaches to national cinemas. Instructor: Herrnstein Smith. 3 units. C-L: Women's Studies 212S

220. Foundations in Feminist Theory. 3 units. C-L: see Women's Studies 220

225S. Teaching Race, Teaching Gender. 3 units. C-L: see African and African American Studies 297S; also C-L: Women's Studies 297S, History 297S

251S. Methods and Theories of Romance Studies. 3 units. C-L: see Romance Studies 201S

253. Special Topics in Literature of the Modern Era. Study of a particular author, genre, or theory of modern literature. Topics include changing understandings of authorship, questions of reception, translation, and the history of criticism. Instructor: Staff. 3 units.

255. Special Topics in Literature. Topics vary by semester. Instructor: Staff. 3 units.

255S. Special Topics in Literature. Topics vary each semester. Instructor: Staff. 3 units.

260. Twentieth-Century Reconceptions of Knowledge and Science (DS4). Key texts and crucial issues in contemporary history, sociology, and philosophy of science—or, as the assemblage is sometimes called, 'science studies.' Focus on theoretical and methodological problems leading to (a) critiques of classical conceptions of knowledge and scientific truth, method, objectivity, and progress, and (b) the development of alternative conceptions of the construction and stabilization of knowledge and the relations between scientific and cultural practices. Readings include L. Fleck, K. Popper, P. Feyerabend, T. Kuhn, S. Shapin and S. Schaffer, and B. Latour. Instructor: Herrnstein Smith. 3 units. C-L: English 280

261S. Critical Studies in New Media. 3 units. C-L: see Information Science and Information Studies 250S; also C-L: Art History 250S, Visual Studies 250AS

262. Body Works: Medicine, Technology, and the Body in Early Twenty-first Century America. 3 units. C-L: see Information Science and Information Studies 270; also C-L: Philosophy 270

263S. Post-Digital Architecture. Impact of advanced technology on conceptions of architectural design, new urban environments, & the body since the mid-1990s. Postmodernism & role of time-based new media, game environments & virtual worlds technologies in the rise of digital architecture from the late 1990s-2000s. Theoretical readings from Deleuze, Pask, Grosz, Massumi, Denari, Eisner, Koolhaas, Lynn, Diller + Scofidio. Explores programs for post-digital architecture that integrate nano & biomimetic technologies, smart materials & protocols into self-organizing designs for living architecture & reflexive environments. Discuss how post-digital architecture will engage the work of Simondon, Spillers, Armstrong, others. Topics course. Instructor: Lenoir. 3 units. C-L: Information Science and Information Studies 263S

270. Consciousness and Modern Society. 3 units. C-L: see German 270

272S. Wittgensteinian Perspectives on Literary Theory. Key questions in literary theory reconsidered from the point of view of ordinary language philosophy (Wittgenstein, J. L. Austin, Cavell). Topics will vary, but may include: meaning, language, interpretation, intentions, fiction, realism and representation, voice, writing, the subject, the body, the other, difference and identity, the politics of theory. New perspectives on canonical texts on these subjects. Instructor: Moi. 3 units. C-L: English 272S

279. Special Topics in Film. Selected film directors with attention to their visual style. Auteur theory or authorship as a way of understanding the cinematic work of European, American, Asian, or African masters of the form. Instructor: Lentricchia. 3 units.
280S. Literary Guide to Italy. 3 units. C-L: see Italian 221S; also C-L: German 221S

281. Paradigms of Modern Thought. Specialized study of the work of individual thinkers who have modified our conceptions of human reality and social and cultural history, with special emphasis on the form and linguistic structures of their texts considered as 'language experiments.' Topics vary from year to year, including: Marx and Freud, J.P. Sartre, and Walter Benjamin. Instructor: Jameson, Moi, Mudimbe, or Surin. 3 units.

281S. Special Topics in Literature: Paradigms of Modern Thought. Specialized study of the work of individual thinkers who have modified our conceptions of human reality and social and cultural history, with special emphasis on the form and linguistic structures of their texts considered as 'language experiments.' Topics vary from year to year, including: Marx and Freud, J.P. Sartre, and Walter Benjamin. Seminar version of LIT 281. Instructor: Jameson or staff. 3 units.

283. Modernism. Aspects of the "modern," sometimes with emphasis on the formal analysis of specific literary and nonliterary texts (Joyce, Kafka, Mahler, Eisenstein); sometimes with a focus on theories of modernism (Adorno), or on the modernism/postmodernism debate, or on the sociological and technological dimensions of the modern in its relations to modernization, etc. Instructor: Jameson or Lentricchia. 3 units.

284. The Intellectual as Writer. History and theory of the literary role of the intellectual in society (e.g., in Augustan Rome, the late middle ages, the Renaissance, America, Latin America). Instructor: Jameson, Lentricchia, Moi, Mudimbe, or Surin. 3 units.

284S. Antonio Gramsci and the Marxist Legacy. 3 units. C-L: see Italian 230S

286. Topics in Legal Theory. A consideration of those points at which literary and legal theory intersect (e.g., matters of intention, the sources of authority, the emergence of professional obligation). Instructor: Staff. 3 units.

287BS. Ethnohistory of Latin America. 3 units. C-L: see Cultural Anthropology 287S; also C-L: History 287BS

290. Topics in Psychoanalytic Criticism. Instructor: Moi or Viego. 3 units.

293. Special Topics in Literature and History. Relationship of literary texts to varieties of historical experience such as wars, periods of revolutionary upheaval, periods of intense economic growth, "times of troubles," or stagnation. Literary texts and historical content posed in such formal ways as the theoretical problem of the relationship between literary expression and form and a range of historical forces and phenomena. Instructor: Jameson or Kaplan. 3 units.

294S. Special Topics: Theories of the Image. Different methodological approaches to theories of the image (film, photography, painting, etc.), readings on a current issue or concept within the field of the image. Examples of approaches and topics are feminism, psychoanalysis, postmodernism, technology, spectatorship, national identity, authorship, genre, economics, and the ontology of sound. Instructor: Gaines, Jameson, or Mottahedeh. 3 units.

295. Special Topics in Representation in a Global Perspective. Problems of representation approached in ways that cross and question the conventional boundaries between First and Third World. Interdisciplinary format, open to exploration of historical, philosophical, archeological, and anthropological texts as well as literary and visual forms of representation. Instructor: Dorfman, Jameson, or Mignolo. 3 units.

297. Topics in Cultural Studies. Instructors: Gaines, Radway, Surin, and staff. 3 units.

298. Special Topics. Subjects, areas, or themes that cut across historical eras, several national literatures, or genres. Instructor: Staff. 3 units.

301. Language and Theory in the Twentieth Century. A seminar examining some of the most significant analyses, controversies, and achievements of the various disciplinary approaches to language during the past century and their implications for cultural study. Topics include the question of linguistics as a science, the muddle of meaning and interpretation, approaches to communication as social interaction, the Chomskian episode, and poststructural/postanalytic conceptions and contributions. Instructors: B. H. Smith and Tetel. 3 units.

302. Seminar in Emergent Literatures. An advanced seminar in the literature of Third World or nonwestern countries. Specific topics vary from year to year. Instructor: Dorfman. 3 units.

303. History of Criticism. Theories of art and literature from Plato and Aristotle to the early twentieth century. Special emphasis on the period from 1750 to 1900. Instructor: Moi or staff. 3 units.

304. History of Literary Institutions. History of the university, the development of the disciplines of literary study, especially English and Comparative Literature, and of the various supporting institutions, practices, and technologies of literary study. Consent of instructor required. Instructor: Radway, Hernstein Smith, or staff. 3 units.

305S. Space, Place and Power. 3 units. C-L: see Cultural Anthropology 306S; also C-L: Women's Studies 306S

352. Early Modernism 1870-1914. 3 units. C-L: see English 352

353. Special Topics in Literature. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

353S. Seminars in Literature. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

354. Stanley Cavell and Ordinary Language Philosophy. Reading Stanley Cavell's "The Claim of Reason." Exploring the relevance of ordinary language philosophy for the humanities. Key themes are language, responsibility, community, literature,
**Marine Science and Conservation**

Professor Van Dover, *Director and Chair*; Associate Professor Campbell, *Director of Graduate Studies*; Professors C. Bonaventura (environment and cell biology), Crowder (environment and biology), Forward (environment and biology), Rittschof (environment and biology), Van Dover (environment); Associate Professors Campbell (environment), Halpin (environment), Nowacek (environment and engineering) and Read (environment); Assistant Professor Basurto (environment); Professor Emeritus Barber (environment and biology); Associate Professor of the Practice Emeritus Kirby-Smith (environment); Research Scientists Johnston (environment) and Schultz (environment); Assistant Research Scientist Friedlaender (environment); Visiting Research Professor Palkovacs (environment)

The Division of Marine Science and Conservation, one of three academic units in the Nicholas School of the Environment, offers graduate study for students wishing to earn the PhD degree. The Division offers two PhD concentrations: 1) Marine Biology, and 2) Marine Conservation Biology and Policy. Doctoral students in both concentrations emphasize research as a major part of their degree programs. The concentration in Marine Biology is designed to prepare students for careers in university teaching and research. This concentration requires students to concentrate their study and research within a well-defined subject area in marine biology and ecology. The concentration in Marine Conservation Biology and Policy is designed to ensure that students receive detailed training in either natural or social science while, at the same time, are able to synthesize information from both fields. Students in this concentration will be prepared for careers either in university teaching or research, or outside of the university involving the application of science to policy-making. Applicants are strongly encouraged to contact individual faculty members with whom they wish to work prior to applying to the Graduate School.

For more information, please see our Web site: [http://www.nicholas.duke.edu/marinelab/programs/graduate](http://www.nicholas.duke.edu/marinelab/programs/graduate)

See the Marine Laboratory Web site for the current schedule of courses.

**Biology 207AL. Experimental Tropical Marine Ecology.** Consent of instructor required. Instructor: Diaz. 2 units.

**Biology 207BL. Marine Ecology of the Pacific Coast of California.** Prerequisite: Concurrent registration in Biology 129L and consent of instructor. Instructor: Crowder. 2 units.

**Biology 207EL. Harmony in Brittany: French Use of Marine Environments.** Prerequisites: AP Biology or introductory biology and consent of instructor. Instructor: Van Dover. 2 units.


**Biology 254, Vertebrate and Invertebrate Endocrinology.** Prerequisites: AP Biology or introductory biology or consent of instructor and Chemistry 152L. A biochemistry course recommended. (Given at Beaufort.) Instructor: Rittschof. 3 units.

**Biology 297. Research Independent Study.** Instructor: Staff. 3 units.

**Cell Biology 210. Research Independent Study.** Consent of instructor required. Instructor: Staff. Variable credit.

**Cell Biology 243. Respiratory Proteins and the Environment.** (Given at Beaufort.) Prerequisites: organic chemistry or consent of instructor. Instructor: C. Bonaventura. 3 units. C-L: Environment 243

**Environment 225. Coastal Ecotoxicology & Pollution.** (Given at Beaufort.) Prerequisites: introductory chemistry and biology. Instructor: C. Bonaventura. 3 units.

**Environment 243. Respiratory Proteins and the Environment.** 3 units. C-L: see Cell Biology 243

**Environment 249. Green Futures: Exploring Environmental, Economic, and Social Sustainability.** (Given at Beaufort.) Prerequisites: None for graduate students. Undergrads: Introductory Biology and Environmental Science and Policy or consent of instructor. Instructor: Rittschof. 3 units.

**Environment 251D. International Conservation and Development.** Consent of instructor required. (Given at Beaufort.) Instructor: Campbell. 3 units.

**Environment 256S. Seminar in Ocean Sciences.** Consent of instructor required. (Given at Beaufort.) Instructor: Staff. 2 units.

**Environment 273. Marine Fisheries Policy.** (Given at Beaufort.) Instructor: Orbach. 3 units.

**Environment 298. Special Topics.** Instructor: Staff. Variable credit.

**The Master of Arts in Teaching Program**

Ginny Buckner Anomelechi, *Director*
The Master of Arts in Teaching program (MAT) is designed for talented liberal arts graduates who wish to teach their discipline in secondary schools. The MAT degree requires 36 units of graduate credit, consisting of 15 units (five courses) within the student’s discipline, nine units (three courses) of MAT-specific education courses, and 12 units devoted to a year-long internship/seminar and a master’s portfolio. The program is open to students with strong undergraduate preparation in English, mathematics, the sciences, or social studies. A joint-degree program (Master of Environmental Management/Master of Arts in Teaching General Science) is available.

More information on the program is available from the MAT office, 1364 Campus Drive, 01 West Duke Building, Box 90093, Duke University, Durham, North Carolina 27708-0093, or on the Web at http://www.duke.edu/web/MAT/ or by e-mail: MAT-Program@duke.edu.

Master of Arts in Teaching Courses (MAT)

302. Educating Adolescents. Focus on understanding the adolescent as a learner. Study of selected theories of adolescent development and theories and principles of educational psychology emphasizing secondary education. Open only to MAT students. Instructor: Staff. 3 units.

303. Effective Teaching Strategies. During the first part of the course students learn general teaching strategies for secondary classrooms such as time management, student behavior management, planning for instruction, instructional presentation, designing effective lessons, feedback, promoting critical thinking skills, and cooperative learning. In the second part students work on methodologies in specific subject area groups. Open only to MAT students. Instructor: Staff. 3 units.

341. Internship and Reflective Practice. During fall semester MAT students are placed in supervised internships in local high schools under the direction of trained and certified mentor teachers. The accompanying seminar provides students with an understanding of the adolescent as learner, and opportunities for directed reflection on themselves as teachers and learners, and their students as learners. Open only to MAT students. Instructor: Teasley. 3 units.

342. Internship and Content Methodology. During spring semester each MAT student changes placements to a different local high school under the supervision of a trained and certified mentor teacher. The seminar brings together interns, high school teachers, and content faculty members in specific subject area groups to explore emerging knowledge in the discipline, and the ways that knowledge is best delivered in the high school classroom. Open only to MAT students. Instructor: Staff. 7 units.

343. Teaching Diverse Learners. Teaching students with specific learning disabilities in the regular classroom; cooperative discipline; cooperative learning, reading in the content area; working with non-English speakers. Open only to MAT students. Co-requisite: MAT 341. Instructor: Staff. 2 units.

344. Teaching Diverse Learners. Continuation of MAT 343 focusing on student assessment, working with families and communities. Emphasis on professional job preparation, including resumes and interview skills. Teaching portfolio serves as final exam. Co-requisite: MAT 342. Open only to MAT students. Instructor: Staff. 1 unit.

399. Independent Study. Independent Study in teaching methods. Open only to MAT students. Consent of Director of Graduate Studies required. Instructor: Staff. Variable credit.

Master of Fine Arts in Experimental and Documentary Art

Associate Professor Abe, Director of Graduate Studies

The Master of Fine Arts in Experimental and Documentary Arts is a terminal degree offered jointly by three academic units: the Department of Art, Art History, and Visual Studies, the Center for Documentary Studies, and the Program in the Arts of the Moving Image. The MFA brings together two forms of artistic activity—the documentary approach and experimental production in analog, digital, and computational media—in a unique program that will foster collaborations across disciplines and media as it trains sophisticated, creative art practitioners.

The MFA in Experimental and Documentary Arts requires fourteen courses over four semesters: ten required courses in prescribed sequence and four elective courses. In order to build cohesion in the program, all matriculating students will enroll in three required courses in the first semester: two studio courses (Documentary Process and Experimental Film/Video) and one seminar (Genealogies and Theories of the Experimental). In the second semester, the cohort will enroll in one required studio course (Computational Media), one seminar (Introduction to Documentary Arts), a Thesis Studio course, and one elective. After a summer of individual thesis research, the second year will focus on studio courses supporting production of the thesis project and seminars on research and writing the thesis. The projects will be presented at an MFA Thesis Exhibition in the fourth semester and a written thesis paper will be submitted.

Additional information and contacts may be found at http://mfaeda.duke.edu.

Mathematics

Professor H. Layton, Chair (113 Physics); Associate Professor Witelski, Director of Graduate Studies (295 Physics); Professors Agarwal, Allard, Aspinwall, Beale, H. Bray, Calderbank, Daubechies, Durrett, Edelsbrunner, Hain, Harer, H. Layton, Liu, Miller, Pardon, Petters, Reed, Rose, Saper, Schaeffer, Schoen, Stern, Transgenstein, Venakides, Zhou; Associate Professors Kraines, Mattingly, Plesser, Witelski; Assistant Professors A. Layton, Maggioni, Mukherjee, Ng, Nolen; Professors Emeriti Kitchen, Model, Moore, Smith, Warner, and Weisfeld; Adjunct Professors Bertozzi, Howard, Shearer,
Graduate work in the Department of Mathematics is offered leading to the PhD degree.

Admission to this program is based on the applicant's undergraduate academic record, level of preparation for graduate study, the Graduate Record Examination general and subject tests, and letters of recommendation.

The department offers research training in both pure and applied mathematics. Major areas of research specialization include algebra and algebraic geometry, analysis and partial differential equations, applied mathematics and scientific computing, differential geometry, geometry and physics, mathematical biology, probability and stochastic processes, and topology. Interdisciplinary programs with connections to the department include the Center for Computational Biology and Bioinformatics, the Center for Geometric and Biological Computing, the Center for Nonlinear and Complex Systems, and the Center for Theoretical and Mathematical Sciences. Our department is a university affiliate for the Statistical and Applied Mathematical Sciences Institute (SAMSI).

All PhD students are required to pass a qualifying examination that has both a written and an oral component; most students complete both components within the first three semesters of graduate study. While students are normally admitted only to the PhD program, the AM degree with a major in mathematics is awarded upon completion of 30 units of graded course work and passing the qualifying examination. Candidacy for the PhD is established by passing an oral preliminary examination. The preliminary examination is normally taken during the third year. By this time the student should have chosen a thesis advisor and demonstrated any computer skills or reading skills in a foreign language judged to be necessary for work in the chosen area. The original research, which begins after successful completion of the preliminary examination, should culminate in the writing and defense of a dissertation. The dissertation is the most important requirement for the PhD degree.

Further details concerning the department, the graduate program, admissions, facilities, the faculty and their research, and financial support may be obtained from our Web site http://www.math.duke.edu/. For inquiries, send e-mail to the director of graduate studies at dgs-math@math.duke.edu.

Mathematics Courses (MATH)

200. Introduction to Algebraic Structures I. Groups: symmetry, normal subgroups, quotient groups, group actions. Rings: homomorphisms, ideals, principal ideal domains, the Euclidean algorithm, unique factorization. Not open to students who have had Mathematics 121. Prerequisite: Mathematics 104 or equivalent. Instructor: Staff. 3 units.

201. Introduction to Algebraic Structures II. Fields and field extensions, modules over rings, further topics in groups, rings, fields, and their applications. Prerequisite: Mathematics 200, or 121 and consent of instructor. Instructor: Staff. 3 units.

203. Basic Analysis I. Topology of $\mathbb{R}^n$, continuous functions, uniform convergence, compactness, infinite series, theory of differentiation, and integration. Not open to students who have had Mathematics 139. Prerequisite: Mathematics 104. Instructor: Staff. 3 units.

204. Basic Analysis II. Differential and integral calculus in $\mathbb{R}^n$. Inverse and implicit function theorems. Further topics in multivariable analysis. Prerequisite: Mathematics 104; Mathematics 203, or 139 and consent of instructor. Instructor: Staff. 3 units.

205. Topology. Elementary topology, surfaces, covering spaces, Euler characteristic, fundamental group, homology theory, exact sequences. Prerequisite: Mathematics 104. Instructor: Staff. 3 units.

206. Differential Geometry. Geometry of curves and surfaces, the Serret-Frenet frame of a space curve, Gauss curvature, Cadazzi-Mainardi equations, the Gauss-Bonnet formula. Prerequisite: Mathematics 104. Instructor: Staff. 3 units.


214S. Modeling of Biological Systems. Research seminar on mathematical methods for modeling biological systems. Exact content based on research interests of students. Review methods of differential equations and probability. Discuss use of mathematical techniques in development of models in biology. Student presentations and class discussions on individual research projects. Presentation of a substantial individual modeling project to be agreed upon during the first weeks of the course. May serve as capstone course for MBS certificate. Not open to students who have had MBS 200S. Prerequisites: Mathematics 107 or 131 or consent of instructor. 3 units. C-L: Modeling Biological Systems 214S, Computational Biology and Bioinformatics 230S

215. Mathematical Finance. An introduction to the basic concepts of mathematical finance. Topics include modeling security price behavior, Brownian and geometric Brownian motion, mean variance analysis and the efficient frontier, expected utility maximization, Ito's formula and stochastic differential equations, the Black-Scholes equation and option pricing formula. Prerequisites: Mathematics 103, 104, 135 or equivalent, or consent of instructor. Instructor: Staff. 3 units. C-L: Economics 225

216. Applied Stochastic Processes. An introduction to stochastic processes without measure theory. Topics selected from:
Markov chains in discrete and continuous time, queuing theory, branching processes, martingales, Brownian motion, stochastic calculus. Prerequisite: Mathematics 135 or equivalent. Instructor: Staff. 3 units. C-L: Statistical Science 253

217. Linear Models. 3 units. C-L: see Statistical Science 244

219. Introduction to Stochastic Calculus. Introduction to the theory of stochastic differential equations oriented towards topics useful in applications. Brownian motion, stochastic integrals, and diffusions as solutions of stochastic differential equations. Functions of diffusions and their connection with partial differential equations. Ito's formula, Girsanov's theorem, Feynman-Kac formula, Martingale representation theorem. Additional topics have included one dimensional boundary behavior, stochastic averaging, stochastic numerical methods. Prerequisites: Undergraduate background in real analysis (Mathematics 139) and probability (Mathematics 135). Instructor: Staff. 3 units.

221. Numerical Analysis. 3 units. C-L: see Computer Science 250; also C-L: Statistical Science 250


228. Mathematical Fluid Dynamics. Properties and solutions of the Euler and Navier-Stokes equations, including particle trajectories, vorticity, conserved quantities, shear, deformation and rotation in two and three dimensions, the Biot-Savart law, and singular integrals. Additional topics determined by the instructor. Prerequisite: Mathematics 133 or 211 or an equivalent course. Instructor: Staff. 3 units.

229. Mathematical Modeling. Formulation and analysis of mathematical models in science and engineering. Emphasis on case studies; may include individual or team research projects. Instructor: Staff. 3 units.

231. Ordinary Differential Equations. Existence and uniqueness theorems for nonlinear systems, well-posedness, two-point boundary value problems, phase plane diagrams, stability, dynamical systems, and strange attractors. Prerequisite: Mathematics 104, 107 or 131, and 203 or 139. Instructor: Staff. 3 units.

232. Introduction to Partial Differential Equations. Fundamental solutions of linear partial differential equations, hyperbolic equations, characteristics, Cauchy-Kowalevski theorem, propagation of singularities. Not open to students who have taken the former Mathematics 297. Prerequisite: Mathematics 204 or equivalent. Instructor: Staff. 3 units.


236. General Relativity. 3 units. C-L: see Physics 292

241. Real Analysis. Measures; Lebesgue integral; $L^k$ spaces; Daniell integral, differentiation theory, product measures. Prerequisite: Mathematics 204 or equivalent. Instructor: Staff. 3 units.

242. Functional Analysis. Metric spaces, fixed point theorems, Baire category theorem, Banach spaces, fundamental theorems of functional analysis, Fourier transform. Prerequisite: Mathematics 241 or equivalent. Instructor: Staff. 3 units.

245. Complex Analysis. Complex calculus, conformal mapping, Riemann mapping theorem, Riemann surfaces. Prerequisite: Mathematics 204 or equivalent. Instructor: Staff. 3 units.

250. Computation in Algebra and Geometry. Application of computing to problems in areas of algebra and geometry, such as linear algebra, algebraic geometry, differential geometry, representation theory, and number theory, use of general purpose symbolic computation packages such as Maple or Mathematica; use of special purpose packages such as Macaulay, PARI-GP, and LiE; programming in C/C++. Previous experience with programming or the various mathematical topics not required. Corequisite: Mathematics 251 or consent of instructor. Instructor: Staff. 3 units.
251. Groups, Rings, and Fields. Groups including nilpotent and solvable groups, p-groups and Sylow theorems; rings and modules including classification of modules over a PID and applications to linear algebra; fields including extensions and Galois theory. Prerequisite: Mathematics 201 or equivalent. Instructor: Staff. 3 units.

252. An Introduction to Commutative Algebra and Algebraic Geometry. Affine algebraic varieties, Groebner bases, localization, chain conditions, dimension theory, singularities, completions. Prerequisite: Mathematics 251 or equivalent. Instructor: Staff. 3 units.

253. Representation Theory. Representation theory of finite groups, Lie algebras and Lie groups, roots, weights, Dynkin diagrams, classification of semisimple Lie algebras and their representations, exceptional groups, examples and applications to geometry and mathematical physics. Prerequisite: Mathematics 251 or equivalent. Instructor: Staff. 3 units. C-L: Physics 293

254. Representation Theory of Lie Groups. Representation theory of Lie groups and Lie algebras, representations of finite groups, harmonic analysis, representations of semisimple Lie groups. Prerequisite: Mathematics 253 or equivalent. Instructor: Staff. 3 units.

260. Algebraic Topology I. Fundamental group and covering spaces, singular and cellular homology, Eilenberg-Steenrod axioms of homology, Euler characteristic, classification of surfaces, singular and cellular cohomology. Prerequisite: Mathematics 200 and 205 or consent of instructor. Instructor: Staff. 3 units.

261. Algebraic Topology II. Universal coefficient theorems, Künneth theorem, cup and cap products, Poincaré duality, plus topics selected from: higher homotopy groups, obstruction theory, Hurewicz and Whitehead theorems, and characteristic classes. Prerequisite: Mathematics 261 or consent of instructor. Instructor: Staff. 3 units.

263. Topics in Topology. Algebraic, geometric, or differential topology. Consent of instructor required. Instructor: Staff. 3 units.

264. Computational Topology. 3 units. C-L: see Computer Science 236

266. Differential Geometry. Differentiable manifolds, fiber bundles, connections, curvature, characteristic classes, Riemannian geometry including submanifolds and variations of length integral, complex manifolds, homogeneous spaces. Prerequisite: Mathematics 204 or equivalent. Instructor: Staff. 3 units.

267. Topics in Differential Geometry. Lie groups and related topics, Hodge theory, index theory, minimal surfaces, Yang-Mills fields, exterior differential systems, harmonic maps, symplectic geometry. Prerequisite: Mathematics 267 or consent of instructor. Instructor: Staff. 3 units.

270. Riemann Surfaces. Compact Riemann Surfaces, maps to projective space, Riemann-Roch Theorem, Serre duality, Hurwitz formula, Hodge theory in dimension one, Jacobians, the Abel-Jacobi map, sheaves, Cech cohomology. Prerequisite: Mathematics 245 and Mathematics 261 or consent of instructor. Instructor: Staff. 3 units.

271. Algebraic Geometry. Projective varieties, morphisms, rational maps, sheaves, divisors, sheaf cohomology, resolution of singularities. Prerequisite: Mathematics 252 and 272; or consent of instructor advised. Instructor: Staff. 3 units.

272. Number Theory. Binary quadratic forms; orders, integral closure; Dedekind domains; fractional ideals; spectra of rings; Minkowski theory; fundamental finiteness theorems; valuations; ramification; zeta functions; density of primes in arithmetic progressions. Prerequisites: Mathematics 201 or 251 or consent of instructor. Instructor: Staff. 3 units.

273. Topics in Algebraic Geometry. Schemes, intersection theory, deformation theory, moduli, classification of varieties, variation of Hodge structure, Calabi-Yau manifolds, or arithmetic algebraic geometry. Prerequisite: Mathematics 273 or consent of instructor. Instructor: Staff. 3 units.

274. Topics in Complex Analysis. Geometric function theory, function algebras, several complex variables, uniformization, or analytic number theory. Prerequisite: Mathematics 245 or equivalent. Instructor: Staff. 3 units.

275. Hyperbolic Partial Differential Equations. Linear wave motion, dispersion, stationary phase, foundations of continuum mechanics, characteristics, linear hyperbolic systems, and nonlinear conservation laws. Prerequisite: Mathematics 232 or equivalent. Instructor: Staff. 3 units.


277. Topics in Partial Differential Equations. Hyperbolic conservation laws, pseudo-differential operators, variational inequalities, theoretical continuum mechanics. Prerequisite: Mathematics 281 or equivalent. Instructor: Staff. 3 units.

278. Probability. Theoretic probability. Triangular arrays, weak laws of large numbers, variants of the central limit theorem, rates of convergence of limit theorems, local limit theorems, stable laws, infinitely divisible distributions, general state space Markov chains, ergodic theorems, large deviations, martingales, Brownian motion and Donsker's theorem. Prerequisites: Mathematics 241 or Statistics 205 or equivalent. Instructor: Staff. 3 units. C-L: Statistical Science 207

279. Topics in Probability Theory. Probability tools and theory, geared towards topics of current research interest. Possible additional prerequisites based on course content in a particular semester. Prerequisites: Mathematics 135 or equivalent, and consent of instructor. Instructor: Staff. 3 units. C-L: Statistical Science 297

280. Special Topics. Instructor: Staff. 3 units.

281. Special Topics. Instructor: Staff. 3 units.

282. Special Readings. Instructor: Staff. 3 units.
For Graduate Students Only

348. Current Research in Analysis. Not open to students who have taken Mathematics 388, 389. Instructor: Staff. 3 units.
358. Current Research in Algebra. Not open to students who have taken Mathematics 368-369. Instructor: Staff. 3 units.
368. Current Research in Topology. Not open to students who have taken Mathematics 378-379. Instructor: Staff. 3 units.
378. Research in Algebraic Geometry. Mini seminars on current topics which are repeatable for credit. Instructor: Staff. 1 unit.
379. Current Research in Mathematical Physics. Not open to students who have taken Mathematics 387. Instructor: Staff. 3 units.
388. Research in Differential Equations. Mini seminars on current topics which are repeatable for credit. Instructor: Staff. 1 unit.
390. Teaching College Mathematics. This course is designed for first year mathematics graduate students as preparation for teaching as graduate students at Duke and as professors, once they graduate. Topics include lesson planning, overview of the content in calculus courses, current issues in undergraduate mathematics education, writing and grading tests, evaluating teaching and practice teaching. Consent of instructor required. Instructor: Staff. 1 unit.

Medical Historian Training Program
Peter English, MD, Director

The Medical Historian Training Program is conducted under the auspices of the School of Medicine and the Graduate School. The MD/PhD program requires a minimum of six years of graduate and medical study, and the MD/AMAM four or five years, depending on the use of summer terms. The MD/PhD program is intended for those students who know that their major career effort will be in teaching and other scholarly activities in the history of medicine (not necessarily to the total exclusion of clinical medicine). The MD/AM, on the other hand, is appropriate for those who are undecided, but who wish to acquire a firm foundation for future study. In both programs the first two years and the last year will be spent in the Medical School. All requirements for the PhD and the AM must be completed before the final year of the MD program.

Application and Admission Procedures. Applicants must meet the requirements for admission to the School of Medicine and the Graduate School in the Department of History including the MCAT and GRE exams. Those candidates holding the MD degree will be considered for the PhD and the AM degrees. Candidates who have completed two years of medical school will also be considered for either degree.

Applicants should complete and submit an application to the Graduate School for admission to the Department of History. Additional information may be obtained by writing to Dr. Peter English, Box 3675 Duke University Medical Center, Durham, North Carolina 27710.

Medical Physics
Associate Professor Dobins, Director; Professor Samei, Director of Graduate Studies; Professors Das, Dewhirst, Howell, Izatt, Jaszcak, Johnson, Samei, Smith, Allen Song, Spicer, Stauffer, Trahey, Vaidyanathan, Qiwen Wu, Yin, Zalutsky; Associate Professors Badea, Bida, Chin, Das, Dobins, Driehuys, Lo, MacFall, Oldham, Tornai, Tourassi, Turkington, Vujaskovic, Wax, Wong, Jackie Wu, Ying Wu, Yoshizumi; Assistant Professors Chen, Driehuys, Kapadia, Liu, Kirkpatrick, Segars, Haijun Song, Wang; Medical Physicist Bowsher

Medical physics is a discipline that applies physics to the needs of medicine, and has been instrumental in the development of the medical fields of radiology, radiation oncology, and nuclear medicine. The Medical Physics Graduate Program offers MS and PhD degrees, and is organized into four academic tracks: diagnostic imaging physics, radiation oncology physics, nuclear medicine physics, and medical health physics. Graduates are trained for employment opportunities in academic settings, clinical service, industry, or government labs. The medical physics program is a collaborative interdisciplinary program, and the faculty are drawn from the sponsoring departments of radiology, radiation oncology, occupational and environmental safety (health physics), biomedical engineering, and physics. Current research interests of the faculty include magnetic resonance imaging and microscopy, advanced digital imaging instrumentation and algorithms, detector and display characterization, computer-aided diagnosis, ultrasound, monoclonal antibody imaging and therapy, intensity modulated radiation therapy, on-board imaging in radiation therapy, SPECT and PET imaging, neutron-stimulated imaging, and dosimetry. All students take common core courses in the first year, followed by concentration in a major track of study. An NIH training grant is available on a competitive basis for PhD students and there is an optional summer clinical internship for MS students. The program is accredited by the Council on Accreditation of Medical Physics Educational Programs.

Medical Physics Courses (MEDPHY)
200. Radiation Physics. A course covering the basics of ionizing and non-ionizing radiation, atomic and nuclear structure, basic nuclear and atomic physics, radioactive decay, interaction of radiation with matter, and radiation detection and
doimetry. Consent of instructor required. Instructor: Gunasingha. 3 units.

205. Anatomy and Physiology for Medical Physicists. A course focused on medical terminology, biochemistry pertaining to MP, basic Anatomy and physiology, elementary tumor and cancer biology, and overview of disease in general. Upon completion, the student should: (a) understand anatomic structures, their relationships, their cross-sectional and planar projections, and how they are modified by attenuation and artifacts in the final images; (b) understand the physiology underlying radionuclide images, (c) understand how (a) - (b) are modified by disease, (d) identify anatomical entities in medical images (different modalities), and (e) identify basic features in medical images (e.g., Pneumothorax in chest radiographs, microcalcofications in mammograms). Consent of instructor required. Instructor: Reiman. 3 units.

210. Radiation Protection. Course discusses the principles of radiation protection dealing with major forms of ionizing and non-ionizing radiation, the physics and chemistry of radiation biology, biological effects of ionizing and non-ionizing radiations (lasers, etc.) at cellular and tissue levels, radiation protection quantities and units, medical HP issues in clinical environments, radiation safety regulations, and basic problem solving in radiation safety. Consent of instructor required. Instructor: Yoshizumi. 3 units.

220. Radiation Therapy Physics. This introductory course has a clinical orientation, and reviews the rationale, basic science, methods, instrumentation, techniques and applications of radiation therapy to the treatment of a wide range of human diseases. Major radiation modalities are covered including low and high energy photon therapy, electron and proton therapy, and low and high-dose rate brachytherapy. The clinical process of treatment, methods of calculating dose to patient, and the role of the medical physicist in radiation oncology clinic, are covered in detail. Consent of instructor required. Instructor: Oldham. 3 units.

230A. Modern Medical Diagnostic Imaging System. This course covers the mathematics, physics and instrumentation of several modern medical imaging modalities starting with a review of applicable linear systems theory and relevant principles of physics. Modalities studied include X-ray radiography (film-screen and electronic), computerized tomography, ultrasound and nuclear magnetic resonance imaging. Consent of instructor required. Instructor: MacFall. 3 units.

241. Nuclear Medicine Physics. Topics include basics of nuclear medicine imaging, gas, scintillation, and solid state radiation detectors, counting statistics, gamma camera principles including modern digital designs, SPECT, coincidence imaging principles, PET instrumentation, radionuclide and x-ray CT transmission scanning techniques, nuclear medicine treatments, and surgical probes. Instructor consent required. Instructor: Turkington. 3 units.

251. Seminars in Medical Physics. Medical physics is the application of the concepts and methods of physics and engineering to the diagnosis and treatment of human disease. This course consists of weekly lectures covering broad topics in medical physics including diagnostic imaging, radiation oncology, radiation safety, and nuclear medicine. Lectures will be given by invited speakers drawn from many university and medical center departments including Biomedical Engineering, radiology, physics, radiation safety, and radiation oncology. Prerequisites: background in engineering or physics. 1 CC (0.5 ES/0.5 ED). Consent of instructor required. Instructors: Lo and Oldham. 1 unit.

312. Radiobiology I. Effects of ionizing radiation on biological material from molecular interactions, through sub-cellular levels of organization, to the response of tissues, organs and the whole body. Includes the application of radiation biology, and the biological aspects of environmental radiation exposure. Prerequisites: MEDPHY 200, and MEDPHY 205 Instructor: Kirsch. 2 units.

313. Radiobiology II. Continuation of Radiobiology I. Prerequisite MEDPHY 312 Instructor: Kirsch. 1 unit.

314. Clinical Dosimetry Measurements. This course covers advanced topics in clinical radiation dosimetry that is pertinent to both KV and MV energy range. Initially we will offer as 1 credit hour course in the spring of 2011, but plans to offer as 3-credit course in the future. Prerequisites: MP200, MP205. Instructor: Yoshizumi. Variable credit.

315. Advanced Topics in Radiation Detection and Dosimetry. This series of lectures covers the topics in radiation detectors, measurements and signal processing. The basics of various types of radiation detectors used in nuclear, medical and health physics and their usage are discussed in detail. Prerequisites: MP200, MP205. Instructor: Gunasingha. Variable credit.

316. Clinical Practicum and Shadowing (Medical Health Physics). This practicum course provides hands-on experiences in various hospital health physics functions, in RAM lab oversight, in X-Ray room shielding and verification, and in license prepartion experience under NRC/States oversight. The course includes shadowing a clinician, technologist, or physicist, while performing their routine clinical tasks. Course instructor: Jerry Yoshizumi. 3 units.

322. Advanced Photon Beam Radiation Therapy. This course will cover the physics and clinical application of advanced external beam photon therapies with special emphasis on IMRT. Prerequisite: MP 220. Instructor: Das. 3 units.

323. Advanced Brachtherapy/Special Topics and Procedures. This course covers advanced LDR and HDR brachytherapy, and other selected special topics and procedures. Instructor consent required. Instructor: Yin, Craciunescu, Song. 1 unit.

326. Practicum on Monte Carlo methods in Medical Physics. This course focuses on the fundamentals of Monte-Carlo simulations and provides hands-on experience with clinical Monte-Carlo codes used in medical dosimetry. The course will introduce software such as MCNP, EGS, FLUKA, GEANT and Penelope and companion data analysis software ROOT, PAW and CERNLIB. Students will study at least one major code and will perform two or more projects based on a clinically relevant task. Prerequisites: Calculus, modern physics, and programming. Knowledge of C, C++, or Fortran would be a plus. Instructor: Gunasingha. Variable credit.
327. Observership in Clinical Radiation Oncology. The course aims to provide an appreciation for the practical procedures, realities, and workflow that pertains to the clinical practice of radiation oncology. Through a shadowing arrangement, the students will be directed by a clinical oncologist to experience the decision making processes, the interface with various members of the treatment team, the treatment planning, and the interface with the physics staff. Prerequisites: Medical Physics 220 and 322 (or Medical Physics 322 concurrently). Instructor: Kirkpatrick. 1 unit.

328. Clinical Practicum and Shadowing (RT). The course gives hands-on experience in practical aspects of medical physics as applied to radiation therapy. Special emphasis is given to the operation of various therapy units and dose measuring devices, techniques of measuring the characteristics of radiation beams, commissioning and quality assurance checks for radiation producing devices in the clinic. The course includes shadowing a clinician, technologist, or physicist, while performing their routine clinical tasks. Consent of instructor required. Instructor: Wong. 3 units.

329. Medical Physics Clinical Internship. The course offers an internship opportunity to students who wish to gain a more hands-on, practical experience in clinical aspects of the practice of medical physics. The internship will be conducted in a clinical facility under the supervision of a clinical a medical physicist. Instructor: Yin. 10 units.

330. Advanced Medical Imaging Physics. The course includes advanced topics in diagnostic imaging including linear system theory, image quality metrology, digital radiography and mammography, new advances on three-dimensional imaging modalities, MRI, CT, ultrasound, and evaluation of diagnostic imaging methods. Prerequisite: MP 230. Consent of instructor required. Instructor: MacFall. 3 units.

331. Molecular Imaging. The course covers topics related to imaging molecular processes in small animal and human applications. Instructor: Mukundan. 1 unit.


333. Basic Concepts of Internal Radiation Dosimetry. This course covers the physical and anatomical/physiological foundations of internal radiation dosimetry. Topics covered include definition of dose, absorbed fractions, residence times and methods to determine them, the and the MIRD methodology. Strategies to convert small animal radiopharmaceutical biodistribution data to humans will also be covered. Prerequisites: MP200, MP205. Instructor: Reiman. Variable credit.

334. Clinical Practicum and Shadowing (Diagnostic Imaging). Review and real-life exercises on principles of modern medical imaging systems with emphasis on the engineering and medical physics aspects of image acquisition, reconstruction and visualization, observations of imaging procedures in near clinical settings, and hands-on experience with the instruments. Modalities covered include ultrasound, CT, MRI, nuclear medicine and optical imaging. Medical Physics students will substitute X-ray imaging for the Nuclear imaging module. Prerequisite: BME 233/MP230 or equivalent. Instructor: Samei. 3 units.


337. Clinical Practicum and Shadowing (NM). The course gives hands-on experience in clinical nuclear medicine. Students will work with gamma cameras, PET systems, surgical probes, does calibrators, technetium generators, well counters to learn operation principles, calibration, and quality control methods. Students will spend time in the PET facility, nuclear cardiology, nuclear medicine, and the radiopharmacy. The course includes shadowing a clinician, technologist, or physicist, while performing their routine clinical tasks. Consent of instructor required. Instructor: Turckington. 3 units.

338. Independent Study in Medical Physics. An independent research project with faculty advisor. Consent of instructor required. Instructor: Staff. Variable credit.

339. Public Speaking for Medical Physics. An overview of effective communication techniques for scientists and engineers. Course will focus on speech and delivery, structure of effective presentations, and proper use of visual aids. Students will be required to actively participate in exercises on extemporaneous speaking, formal research presentations, and question and answer sessions. Consent of instructor required. Instructor: Staff. 1 unit.

340. Biostatistics for Medical Physics. The first part will introduce the basic principles of descriptive statistics, probability theory, estimation theory, correlation and regression, with applications in the biomedical field. This is a 2 week session. The second part covers inferential biostatistics. It will introduce statistical hypothesis testing and its application to group comparisons of biomedical data. This part will cover parametric and non-parametric statistical tests and the basics of ANOVA analysis. This is a 2-week session. The third part covers medical decision analysis. This section includes the study and application of decision analysis methods popular in medical decision making. This part will cover performance evaluation measures of medical diagnostic tests, strategies for combining diagnostic tests, receiver operating characteristics analysis and its variants, and cost-effectiveness analysis. This is a 2-week session. 3 course credits each session. Repeatable for 3 total credits. Instructors: Georgia Tourassi, Anuj Kapadia. 1 unit.

341. Frontiers of Biomedical Science. A course covering the frontier topics of biomedical science that are currently not within the domain of medical physics, but a medical physicists, nonetheless, need to have knowledge of. Topics include genomics, bioinformatics, proteomics, and others. Instructor: Wong. 3 units.
Medical Scientist Training Program
Christopher D. Kontos, MD, Director

The Medical Scientist Training Program, administered under the auspices of the Graduate School and the School of Medicine, is designed for students with strong backgrounds in science who are interested in careers in the medical sciences and academic medicine. The program combines graduate education in the sciences basic to medicine with the clinical curriculum of the School of Medicine. It typically requires seven to eight years of study and leads to both the MD and PhD degrees. The combination of basic science and clinical training affords a remarkable range of career opportunities for program graduates, who generally follow one of two broad paths: Some pursue careers in teaching and research in one of the basic medical sciences; others enter residency programs and then go on to investigative and teaching careers in clinical medicine. Most graduates pursue some combination of research and clinical work.

Eligibility. Applicants must meet both the Graduate School PhD admission requirements and the School of Medicine MD admission requirements. Most apply for admission to the first year of the MD program, but a few students are admitted each year after completing the second or third year of Duke University School of Medicine. In addition to the minimum requirements for acceptance into the Graduate School and the School of Medicine, advanced course work in science and mathematics and significant prior research experience are key elements in the selection of new students. Evidence of the potential for serious investigative work as a physician-scientist is essential. Because a significant portion of the program's funding is provided by a National Institutes of Health training grant, program participants must be United States citizens or official permanent residents of the US.

The Training Program. Duke University School of Medicine’s unique third-year research curriculum is well suited for dual-degree programs. The third year of medical school is essentially the first year of the PhD program, an arrangement that shortens the time-to-degree for the dual-degree student by a year. The typical student spends the first two years in medical school, followed by four to five years in a PhD program (which substitutes for the third medical school year) and, finally, returns to a fourth year of medical school. The coursework in the first medical school year provides a solid foundation in the basic medical sciences. The second year is devoted to a clinical sciences curriculum. Following completion of the second year, the trainee enters a graduate program to complete requirements for the PhD degree. A final academic year of elective clinical study completes the requirements for the MD degree.

The typical student follows the plan outlined above, but students whose research interests are well developed early in the first year may opt to begin the PhD at the beginning of their second year and then complete the clinical sciences curriculum after finishing the PhD. While this is not the typical sequence, considerable latitude is granted to students interested in early research experiences.

Financial Support. All students admitted to the program receive a full fellowship award: tuition, fees, health insurance, and a stipend to cover living expenses. The stipend for 2010-2011 is $27,096 for a twelve-month year. The award increases each year to match increases in fees, tuition, and living expenses. The program provides fellowship funds for the three medical school years and the first twenty-two months of enrollment in the PhD program; the PhD mentor provides financial support in the upper-level PhD years. Tuition for the third year of medical school is forgiven for MSTP students who 1) enter the program prior to the third year of medical school and 2) subsequently complete the PhD. Likewise, financial support for the fourth medical school year is contingent upon completion of the PhD, and, in order to qualify for this support in the last medical school year, the student must complete the PhD within seven years of the end of the second medical school year. Because MSTP fellowship support is intended to enable students to devote full time to their work toward the two degrees, all years of fellowship support are contingent upon enrollment in either the School of Medicine or the Graduate School, satisfactory progress toward the two degrees, and no gainful employment.

Additional information may be obtained by contacting the program office directly: Medical Scientist Training Program, Box 102005, Duke University Medical Center, Durham, North Carolina 27710; MSTP@duke.edu; 919-668-5528.

Middle Eastern Studies

A certificate is available in this program.
Requirements:
• Complete four graduate courses on a topic related to the Middle East. One of the courses must be “Critical Genealogies of Middle East Studies.”
• Participate in a bi-weekly workshop organized by the Consortium in Middle East Studies
• Submit to the Consortium a thesis, dissertation, or chapter of a dissertation, or a major seminar paper, on a topic related to Middle Eastern Studies.
• Demonstrate relevant language skills, or international experience or training, which would be research, field work, or study in a Middle Eastern country.
The Department of Molecular Cancer Biology at Duke University seeks to understand the complex regulatory mechanisms that govern mammalian cell growth and differentiation, discern how these mechanisms are perturbed in malignant cells, and how our knowledge of these regulatory mechanisms might lead to improved anti-cancer therapy. This research covers the boundaries of disciplines such as pharmacology, biochemistry, molecular biology, genetics and cell biology, and has increased our knowledge of the basic mechanisms underlying growth regulation. To understand how and why these mechanisms fail, and how their failure results in the initiation of cancer requires an understanding of the molecules involved in chemically and cellullarly precise terms, so as to decipher their ultimate impact on the growth and development of the organism.

The Program in Molecular Cancer Biology includes faculty from nine participating departments. Program scientists are actively engaged in dissecting the regulatory networks that control the processes of growth and development at the cellular and molecular levels, and the defects that lead to oncogenic transformation.

The approaches used by the investigators range from classical genetics to cell and molecular biology and protein biochemistry. An ultimate goal is identifying novel candidates for therapeutic intervention of oncogenesis. Graduate training in this program is greatly enhanced by the interaction between investigators.

### Molecular Cancer Biology Courses (MOLCAN)

**208. Stem Cell Course.** 3 units. C-L: see Cell Biology 208; also C-L: Pharmacology and Cancer Biology 208

**210. Independent Study in Molecular Cancer Biology.** Consent of instructor required. Instructor: Staff. 1 unit.

**280. Advances in Cancer Research.** A presentation and discussion course in which program faculty and graduate students review the recent progress in areas of cancer research being investigated at Duke University. Provides an important avenue for evaluation and feedback for graduate student research and is required each year for all students pursuing their Ph.D. degree in molecular cancer biology. Instructor: Staff. 2 units.

**300. Cancer as a Disease.** Instructor: Wechsler-Reya. 2 units.

**417. Cellular Signaling.** 3 units. C-L: see Cell Biology 417; also C-L: Biochemistry 417, Pharmacology and Cancer Biology 417

**418. Molecular Mechanisms of Oncogenesis.** Lectures, oral presentations, and discussions on advanced topics and recent advances in the molecular biology of cancer. Particular emphasis on strategies to exploit this information in the design of intervention strategies to selectively block the growth of cancer cells. Instructor consent required. Prerequisite: Cell Biology 417. Instructor: Counter and Yao. 2 units. C-L: Pharmacology and Cancer Biology 418

### Molecular Genetics and Microbiology

Professor Heitman, Chair (322 CARL); Assistant Professor Valdivia, Director of Graduate Studies (271 Jones); Professors Cullen, Garcia-Blanco, Goldstein, Heitman, Jinks-Roberson, Keene, Linney, Marchuk, Nevins, Petes, and Willard; Associate Professors Aballay, Dietrich, Matsunami, McCusker, Mitchell, Pickup, Valdivia; Assistant Professors Aballay, Chi, Coers, Luftig, Sullivan

The Department of Molecular Genetics and Microbiology offers a range of opportunities for training in the use of molecular and genetic tools to solve biological problems. Current research interests are focused in microbial pathogenesis, RNA biology, virology, and experimental genetics and genomics. Members of the Department use a wide variety of experimental approaches (e.g., classical genetics, generation of transgenic animals, tissue culture models) and study a diversity of organisms (budding yeast, Cryptococcus, fruit flies, worms, zebrafish, and humans). The Department is extremely interactive. In addition to course work, students participate in a number of...
activities that enhance their training and facilitate interaction with each other, as well as with post-doctoral fellows and faculty. Refer to http://mgm.duke.edu for more information.

Molecular Genetics & Microbiology Courses (MGM)

203. Research Independent Study. Independent research in Molecular Genetics and Microbiology. Instructor: Staff. 3 units.

221. Computational Gene Expression Analysis. 1 unit. C-L: see Computational Biology and Bioinformatics 221; also C-L: Statistical Science 278

222. Critical Readings in Genetics and Genomics. 3 units. C-L: University Program in Genetics 222

232. Human Genetics. Topics include segregation, genetic linkage, population genetics, multifactorial inheritance, biochemical genetics, cytogenetics, somatic cell genetics, neurogenetics, cancer genetics, clinical genetics, positional cloning, complex disease. Lectures plus weekly discussion of assigned papers from the research literature. Prerequisites: University Program in Genetics 278 or equivalent, and graduate status or consent of instructor. Instructors: Marchuk, Pericak-Vance, and Speer. 3 units. C-L: University Program in Genetics 232

252. Virology. Molecular biology of mammalian viruses, with emphasis on mechanisms of replication, virus-host interactions, viral pathogenicity, and the relationship of virus infection to neoplasia. Instructor: Cullen and staff. 3 units.

282. Microbial Pathogenesis. Modern molecular genetic approaches to understanding the pathogenic bacteria and fungi. Underlying mechanisms of pathogenesis and host-parasite relationships that contribute to the infectious disease process. Instructor: McCusker, Abraham, and staff. 3 units.

300. Gene Regulation. Principles of prokaryotic and eukaryotic gene regulation at transcriptional and post-transcriptional levels. Topics include promoter structure and transcription factor function; processing, transport, and degradation of mRNA translation. Gene regulatory pathways. Instructor: Staff. 3 units.

301. Topics in Molecular Genetics and Microbiology. Presentations by MGM students on their current research. Required course for all graduate students specializing in MGM. Credit grading only. Instructor: Staff. 1 unit.

302. Papers and Grant Writing Workshop. Introduction to grant and fellowship writing; writing assignment of two proposal topics; evaluation and critique of proposal by fellow students. Instructor: Staff. Variable credit.

378. Genetic Approaches to the Solution of Biological Problems. 4 units. C-L: see University Program in Genetics 378; also C-L: Cell and Molecular Biology 378, Biology 378

Music

Professor Hawkins, Chair; Associate Professor Rupprecht, Director of Graduate Studies; Professors Berliner, Brothers, Gilliam, Jaffe, Lindroth, Todd; Associate Professors Meintjes, Rupprecht, Waeger; Assistant Professors McCarthy, Supko; Professor of the Practice Parkins

The Department of Music offers graduate programs leading to the AM and PhD degrees in composition and musicology, and the AM in performance practice.

Applicants for admission to all degree programs will normally have a broad liberal arts background as well as demonstrable musical competence. Those applying to the composition program should submit samples of their compositions with their applications. For the musicology program, applicants should include samples of their writing on musical topics. Upon acceptance to the university, by nomination of the graduate faculty in music, musicology students may also be admitted to the Program in Medieval and Renaissance Studies (see section on Medieval and Renaissance Studies in this bulletin). For the performance practice program, the department encourages applications from advanced musicians who have demonstrated an ability to conduct research about the performance of music in historical contexts. Applicants in performance practice should submit a recording of their work in the field as well as a sample of their writing.

For the PhD degree in composition 17 courses (51 units) are required; no more than four courses (12 units) may be accepted for transfer from another institution. Two courses may be taken in other departments. Students are expected to pass a qualifying examination (in the fourth semester) and a preliminary examination (after completing course work, usually in the sixth semester); before taking the preliminary examination students are asked to submit a portfolio of compositions. Students in composition must also demonstrate knowledge of one foreign language. The dissertation requirements consist of a large-scale composition and an article of publishable quality.

For the PhD in musicology 17 courses (51 units) are required; no more than four courses (12 units) may be accepted for transfer from another institution. Three courses may be taken in other departments. Students are expected to pass a qualifying examination (usually in the second year) and a preliminary examination (after completing course work, usually in the third year). In addition, students must demonstrate knowledge of two foreign languages. Within the framework of the musicology degree students may pursue projects in ethnomusicology, music theory, or performance practice.

For the AM in performance practice 11 courses (33 units) are required. Students are expected to pass a qualifying examination (usually in the second year) and to give a master’s recital (usually toward the end of the first year). They also must demonstrate knowledge of one foreign language.

A more detailed description of each degree program is available upon request from the director of graduate
studies.

**Music Courses (MUSIC)**

**201. Introduction to Musicology.** Methods of research on music and its history, including studies of musical and literary sources, iconography, performance practice, ethnomusicology, and historical analysis, with special attention to the interrelationships of these approaches. Instructor: Staff. 3 units.

**213. Theories and Notation of Contemporary Music.** The diverse languages of contemporary music and their roots in the early twentieth century, with emphasis on the problems and continuity of musical language. Recent composers and their stylistic progenitors: for example, Ligeti, Bartók, and Berg; Carter, Schoenberg, Ives, and Copland; Crumb, Messiaen, and Webern; Cage, Varèse, Cowell, and Stockhausen. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**214S. Introduction To Analysis Of Early Music.** Selected areas of "pre-tonal" music and various analytical methodologies that have been developed to understand them. Content changes, from semester to semester and with different instructors. Possible areas covered include plainchant, trouvère monophony, Machaut, Fifteenth-century polyphony, modal music of the Renaissance, early seventeenth-century repertories. Instructors: Brothers and McCarthy. 3 units.

**215. Music Analysis.** In-depth study of various methods for analyzing tonal music. Approach and content vary by instructor. Instructor: Staff. 3 units.

**217. Selected Topics in Analysis.** An exploration of analytical approaches appropriate to a diversity of music, which may include settings of literary texts, pre-tonal music, and music in oral and vernacular traditions. Prerequisite: Music 215 or consent of instructor. Instructor: Rupprecht or staff. 3 units.

**222. Music in the Middle Ages.** Selected topics. Instructor: Brothers. 3 units. C-L: Medieval and Renaissance Studies 223A

**223. Music in the Renaissance.** Selected topics. Instructor: Brothers or McCarthy. 3 units. C-L: Medieval and Renaissance Studies 223B

**224. Music in the Baroque Era.** Selected topics. Instructor: McCarthy. 3 units. C-L: Medieval and Renaissance Studies 224

**225. Music in the Classic Era.** Selected topics. Instructor: Todd. 3 units.

**226. Music in the Nineteenth Century.** Selected topics. Instructor: Gilliam or Todd. 3 units.

**227. Music in the Twentieth Century.** Selected topics. Instructor: Brothers, Gilliam, or Todd. 3 units.

**228. Collegium Musicum.** An opportunity to study and perform vocal and instrumental music from the Middle Ages through the Baroque. Weekly rehearsals; one or two concerts per semester. Audition and consent of instructor required. Instructor: McCarthy or staff. 1.5 units.

**259. The Biological Basis of Music.** 3 units. C-L: see Neurobiology 259; also C-L: Philosophy 259, Psychology 265

**295S. Composition Seminar.** Selected topics in composition. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**297. Composition.** Weekly independent study sessions at an advanced level with a member of the graduate faculty in composition, producing musical scores (or in some cases, audio documents) which accrue towards the production of a portfolio. Consent of instructor required. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**298. Composition.** Continuation of Music 297. Weekly independent study sessions at an advanced level with a member of the graduate faculty in composition, producing musical scores (or in some cases, audio documents) which accrue towards the production of a portfolio. Consent of instructor required. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**299. Composition.** Continuation of Music 298. Weekly independent study sessions at an advanced level with a member of the graduate faculty in composition, producing musical scores (or in some cases, audio documents) which accrue towards the production of a portfolio. Consent of instructor required. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**317S. Seminar in the History of Music.** Selected topics. Instructor: Staff. 3 units.

**330. Independent Study in Performance Practice and Interpretation.** The exploration of significant interpretive and performance-practice issues as they affect a specific repertory. Weekly meetings with a member of the graduate faculty. Consent of instructor and director of graduate studies required. Instructor: Staff. 3 units.

**382S. Studies in Ethnomusicology.** A theoretical and methodological exploration of ethnomusicological approaches to the study of music and related expressive forms. Topics vary. Instructor: Meintjes. 3 units. C-L: Cultural Anthropology 382S

**390. Independent Study.** With the consent of a graduate faculty member and the approval of the director of graduate studies, the student will undertake a specialized research project of his/her own choosing. Instructor: Staff. 3 units.

**397. Composition.** Weekly independent studies at the doctoral level with a member of the graduate faculty in composition. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**398. Composition.** Weekly independent studies at the doctoral level with a member of the graduate faculty in composition. Instructor: Jaffe, Lindroth, or Supko. 3 units.

**399. Composition.** Weekly independent studies at the doctoral level with a member of the graduate faculty in composition. Instructor: Jaffe, Lindroth, or Supko. 3 units.
Nanoscience
Assistant Professor Anne Lazarides, Director of Graduate Studies (3395 Ciemas)

A certificate is available in this program.

The mission of the Graduate Certificate Program in Nanoscience (CPN) is to educate students in nanoscience disciplines and applications. This graduate certificate program is designed to address the need for an interdisciplinary graduate education in nanoscience that extends beyond the traditional disciplines and skills that are taught within existing departments. In this program, graduate students are educated and mentored in classes, labs and research projects by faculty from many disciplines. Current focus areas within nanoscience that are currently represented at Duke include: i) synthesis of nanostructured materials, ii) fundamental properties of nanostructured materials, iii) nanodevice fabrication and applications, and iv) advanced characterization of nanostructured materials and devices. The disciplines span the physical sciences, engineering, and basic biological-science disciplines that are relevant to nanoscience; the program includes faculty from departments within Arts and Sciences, the Pratt School of Engineering, and the Medical School. Member departments in include: Biology, Biochemistry, Biomedical Engineering, Cell Biology, Chemistry, Computer Science, Electrical and Computer Engineering, Mechanical Engineering and Materials Science, and Physics.

For additional information, contact Professor Anne Lazarides (anne.lazarides@duke.edu).

Requirements:

Participating departments include BCH, BIO, BME, CB, CHM, CS, ECE, MEMS, and PHY. Students are admitted into existing departments or programs of Duke University, and receive their PhD degrees within those degree-granting units (typically but not exclusively a participating department).

- CB xxx, Physics of Biological Polymers in Aqueous Environments.
- CPS 222, Nanocomputers.
- CPS 296.x, Molecular Robotics.
- CPS 296.x, Design of DNA Nanostructures.
- CPS 296.x, Biomolecular Nanotechnology.
- ECE 2xx, Nanoelectronics.
- MEMS 2xx, Nano Surface Characterization.
- MEMS 310, Nanomechanics: From Molecules to Materials.
- NANO 200, Foundations of Nanoscience.
- NANO 201, Nanoscience Laboratory.
- NANO 202, Nanoscience Graduate Seminar.
- PHY 346, Introduction to Theoretical Nanoelectronics.
- Complete an approved project within a research group in Nanoscience, but outside the student’s home research group (example: a rotational training in a Nanoscience lab).
- Participation in the Nanoscience Seminar Series.

For more information, visit http://www.cs.duke.edu/nano/.

Nanosciences Courses (NANOSCI)

310. Foundations of Nanoscale Science and Technology. 3 units. C-L: see Electrical and Computer Engineering 310
312. Nanoscience Graduate Seminar. 1 unit. C-L: see Mechanical Engineering and Materials Science 312
316. Bionanotechnology. Covers nanotechnology, bionanotechnology, introductory structural biological, molecular bioengineering, DNA computing, molecular electronics, and related fields, with a focus on the design, fabrication, use and development of systems with molecular-scale components. Previous knowledge of chemistry or macromolecular structure is not required. The course is appropriate for graduate students and advanced undergrads engineering, computer science, materials science, chemistry, and biomedical fields. Instructor: Labean. 3 units.

Elective Courses in Nanoscience:
Biochemistry
222. Structure of Biological Macromolecules
Biology
295S. Physical Approaches to the Living Cell
Biomedical Engineering
Neurobiology

Professor McNamara, Chair (101I Bryan Research Building); Professor Mooney, Director of Graduate Studies (301C Bryan Research Building); Professors Abou-Donia, Augustine, Bennett, Caron, Chikaraishi, Ehlers, Erickson, Fitzpatrick, Flanagan, Grill, Haglund, W. C. Hall, McClay, Mikati, Mooney, Nadler, Nicoletis, Platt, Purves, Simon, Slotkin, Song, Strittmatter, Turner, Warner, Waldorff, and Wong; Associate Professors Cant, Corless, Feng, Groh, Jarvis, Laskowitz, Lo, Matsunami, McKinnon, Pitt, Skene, Westel; Assistant Professors Adamson, Adcock, Calakos, Eroglu, Huettel, Jiang, Kuo, Lascola, Liedtke, Raghavachari, Soderling, Tracey, Wang, Wechsler-Reya, West, Yang, Yasuda, White; Associate Research Professors Hochgeschwender, Madison, Vitek, Voyvodic; Assistant Research Professor Gloss; Associate Adjunct Professor Reinhart; Assistant Adjunct Professors Williams, Xiong

At a time when many questions in biology have been eloquently answered, both scientists and the public correctly perceive that the brain remains, in fundamental ways, a profound mystery. During the last century tremendous advances have been made in understanding the structure, function, chemistry, and development of the brain. Nonetheless, in both biology and medicine, broad and important questions about this complex organ remain to be answered. These include how genetic instructions are linked to brain development, the basis of learning and memory, the nature of consciousness, and the etiology and proper treatment of neurological diseases such as epilepsy, neurodegenerative diseases such as Alzheimers and Parkinsons, and neurodevelopmental disorders such as autism.

The ways in which neurobiologists approach these problems, while generally reductionist, are diverse. Preeminent are the techniques of molecular biology and molecular genetics, a host of sophisticated imaging and electrophysiological methods for detecting the activity of individual nerve cells or groups of nerve cells, and a wealth of anatomical methods for seeing the structure and connections of nerve cells. Novel and increasingly noninvasive means of imaging the nervous system—by functional nuclear magnetic resonance (fMRI), positron emission tomography (PET), or activity-related magnetic fields—also hold great promise for better understanding the brain. Despite the power of these methods, progress in neurobiology—much as progress in any science—will depend on a few important insights arising from the imagination of neuroscientists who think deeply about these issues.
Neuroscience at Duke is pursued in a variety of departments and setting, all of which are possible sites for students who wish to be trained in this field. Although much of this research is carried out in the Department of Neurobiology at Duke University Medical Center, several clinical and arts and sciences departments also have faculty that perform neuroscience research. There are now more than sixty faculty members associated with the graduate program in neurobiology at Duke. A large and diverse body of students and other professionals are also engaged in neurobiological research.

Students in the graduate program take a core curriculum that covers the major subfields of contemporary neurobiology, but students are generally free to pursue—with the help of faculty advisors—a course of study tailored to their needs, backgrounds, and individual interests. The core courses in the Department of Neurobiology are Basic Neurobiology (202), Student Seminar (280), Concepts in Neuroscience I (319), Concepts in Neuroscience II (320), Frontiers in Neuroscience (325), and Neurobiology Journal Club (326).

For additional information, please visit our Web site at: neurobiology.mc.duke.edu or send an e-mail to nbgrad@neuro.duke.edu.

Neurobiology Courses (NEUROBIO)

202. Basic Neurobiology. Provides an intensive, systematic introduction to the structure and function of the human nervous system, including a survey of human behavioral science and psychopathology. Designed for the first-year (basic science) medical student curriculum, but may also accommodate graduate students interested in systems neuroscience, cognitive science, and human neuroanatomy. Includes lectures, laboratory exercises, clinical presentations, and team-based learning activities. Meets 9am to 5pm, weekdays, during the month of January. Enrollment is by permission of instructor. Instructor: White. 4 units.


212. Research Independent Study. Individual research and reading of the primary literature in a field of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Consent of instructor required. Instructor: Staff. 3 units.


257. Vision. Understanding the machinery of vision and its perceptual consequences. How we see brightness, color, form, motion, depth; the integration of visual and auditory information to generate unified multimodal representations; using vision to probe cognitive aspects of brain function; exploring visual aesthetics. The course is designed for advanced undergraduates and beginning graduate students. Instructor: Fitzpatrick and Purves. 3 units.

259. The Biological Basis of Music. Examine how and why we hear what we do, from intra-species communication to music. Consider the biological basis of music, in particular the relationship between music and speech. Comparison between the operating principles of the auditory system with what is presently known about vision. Limited inquiry into the neurobiology of aesthetics. Instructor: Purves. 3 units. C-L: Philosophy 259, Psychology 265, Music 259

280. Student Seminar. Preparation and presentation of seminars to students and faculty on topics of broad interest in neurobiology. Required of all first- and second-year neurobiology students. Instructor: Yasuda. 1 unit.

319. Concepts in Neuroscience I: Cellular and Molecular Neurobiology. The goal of this course is to introduce graduate students to the basic principles underlying cellular and molecular neurobiology. The first part of the course will cover the cellular mechanisms of neurophysiology, that is the generation and propagation of neuronal electrical signals. The second part will cover molecular mechanisms of synaptic signaling, plasticity, axon guidance, and neural regeneration. An interactive discussion-based format focused on key discoveries in these areas of research, including analysis of original papers, will allow students to learn how the brain encodes, transmits, and stores information as well as form neural circuits. Consent of instructor is required. Instructor: Jarvis. 3 units.

320. Concepts in Neuroscience II: Principles of Organization of Neuronal Systems. The principles of organization of neurons into functional circuits will be examined through a combination of lectures, readings, individual projects, and in-class discussions. Emphasis will be on the sensory and motor systems and their integration into a functional whole. Aspects of development of neuronal circuitry will also be addressed. Prerequisites: NEUROBIO 319 and NEUROBIO 202. Consent of instructor is required. Instructor: Mooney. 3 units.

325. Frontiers in Neuroscience. The goal of this course is to give graduate students in Neurobiology an opportunity to learn about ongoing research projects that represent the state of the art in Neurobiology labs. Twice weekly, each of the primary Neurobiology faculty members meet with the first year students for ninety minutes to present the context and current directions from his/her lab. Instructor: West. 1 unit.
326. Neurobiology Journal Club. Once a month, first and second year neurobiology graduate students meet to hold a student-run journal club to discuss the work of an invited seminar speaker from an outside institution. On the following Tuesday, the students attend the seminar, then have lunch with the speaker. Instructor: West. 1 unit.

333. Statistics for Basic Biomedical Scientists. 2 units. C-L: see Pharmacology and Cancer Biology 333; also C-L: Cell and Molecular Biology 333

349S. Principles in Cognitive Neuroscience I. 3 units. C-L: see Psychology 359S; also C-L: Philosophy 359S

350S. Principles in Cognitive Neuroscience II. 3 units. C-L: see Psychology 360S; also C-L: Philosophy 360S

359. Neuronal Cell Signaling and Related Topics. Using primary literature, this course will cover current topics in neuronal cell signaling, with special emphasis on related diseases as well as the biochemical, molecular, and cellular methods used in these studies. The format of the course will include both student-led presentations reviewing current knowledge on each topic and a journal club discussion of a research paper. The instructor will assist students in choosing the topics and will facilitate the discussion. At the end of the course each student will prepare a grant proposal outlining next steps for the topic researched. Students are expected to have a strong background in neuroscience, and permission of the instructor is required to register. Instructor: West. 3 units.

364. Neurotoxicology. 3 units. C-L: see Pharmacology and Cancer Biology 364


381. Functional Magnetic Resonance Imaging. The course covers all aspects of functional magnetic resonance imaging, from its basic principles in physics, engineering, biophysics, and physiology; through computational, analytic, and signal processing issues; to its applications in neurobiology and cognitive neuroscience. The course will consist of weekly lectures and integrated laboratory sessions. Lectures will be given by BIAC faculty, and will incorporate primary readings in the field to encourage discussion. The laboratory sessions will involve analysis of fMRI data sets that illustrate issues discussed in the lectures. Students will gain experience both in the theoretical principles of fMRI and in the practical aspects of experimental design and data analysis. Instructor: Huettel. 3 units. C-L: Psychology 362

Nonlinear and Complex Systems

Professor Behringer, Director; Professor Virgin, Associate Director; Associate Professor Mattingly, Director of Graduate Studies; Professors Beale (mathematics), Behringer (physics), Dowell (mechanical engineering and materials science) Greenside (physics), Haff (earth and ocean sciences), Hall (mechanical engineering and materials science), Kepler (bioinformatics and biostatistics), Katul (aquistic and atmospheric sciences), Lewis (neurology), Nijhout (biology), Palmer (physics), Rosenberg (philosophy), Schaeffer (mathematics), Trangenstein (mathematics), Venakides (mathematics), and Virgin (mechanical engineering and materials science); Associate Professors Gauthier (physics), Henriquez (biomedical engineering), Howle (mechanical engineering and materials science), Krassowska (biomedical engineering), Krystal (psychology and behavioral science), Layton (mathematics), Socolar (physics), Teitsworth (physics), Wilson (biology), and Wolf (biomedical engineering); Assistant Professors Lin (physics), Liu (chemistry), McShea (biology), Murray (earth and ocean sciences), Sterrett (philosophy), and Witelski (mathematics)

A certificate is available in this program.

The Center for Nonlinear and Complex Systems (CNCS) at Duke University is a well-established interdisciplinary program that links researchers in diverse scientific, mathematical, engineering and medical fields who have a common interest in all aspects of nonlinear dynamical phenomena, especially in complex systems. The activities of the CNCS include graduate and undergraduate training, and the fostering of interdisciplinary research. The center offers a certificate program for graduate students, provides a range of relevant courses, supports a regular seminar series and organizes scientific meetings, such as Dynamic Days as well as focused workshops. It helps foster links among researchers and students at Duke as well as on national and world scales.

The CNCS was officially established in the early ‘90s for the purpose of bringing together faculty at Duke whose research relies on the rapidly developing fields of nonlinear dynamics and complex systems. Anyone in the Duke community with interests in nonlinear dynamics and/or complex systems may choose to be affiliated with the CNCS. At present, members of the center include faculty, post-docs, and students from the departments of Biology, Biomedical Engineering, Cell Biology, Civil and Environmental Engineering, Computer Science, Electrical and Computer Engineering, Earth and Ocean Sciences, Mathematics, Mechanical Engineering and Materials Science, Physics, Neurobiology, Psychiatry.

The CNCS graduate certificate program was created to respond to the need for a broad, interdisciplinary, and transferable set of skills. Certain basic concepts and techniques relevant to dynamical systems are now widely used in a many different disciplines. This program is intended to guide students toward this broad view by requiring the completion of a survey course, participation in seminars, and course work.

Requirements:
Students are admitted into existing Duke PhD departments associated with the Center, and elect to begin their certificate program in the first or second year of graduate study. Must complete the following:

- Survey course (CNCS 201: Topics in Nonlinear and Complex Systems).
- Four courses from an approved list.
- Dissertation on a topic in the domain of the center.
- Two Center faculty members must be on the student's dissertation committee.

For more information, visit http://www.math.duke.edu/cnacs/courses.html.

**Approved Courses for the Graduate Certificate Program in Nonlinear and Complex Systems:**

**Biology**
268. Ecological Theory and Data
291. Mathematical Biology
292. Population Ecology
293. Simulating Ecological and Evolutionary Systems
303. Principles of Ecological Modeling
304. Plant Growth Modeling

**Biomedical Engineering**
201. Electrophysiology
204. Measurement and Control of Cardiac Electrical Events
207. Transport Phenomena in Biological Systems
212. Theoretical Electrocardiology
213. Nonlinear Dynamics in Electrophysiology
216. Transport Phenomena in Cells and Organs
229. Tissue Mechanics
231. Intermediate Biomechanics
239. Cell Transport Mechanisms
244. Mathematical Models of Physiological Systems
246. Computational Methods in Biomedical Engineering
250. Cardiovascular Mechanics
331. Viscoelasticity

**Civil and Environmental Engineering**
201. Advanced Mechanics of Solids
303. Plasticity
207. Transport Phenomena in Biological Systems
210. Intermediate Dynamics
225. Dynamic Engineering Hydrology
237. Advanced Soil Mechanics
245. Pollutant Transport Systems
252. Buckling of Engineering Structures
255. Nonlinear Finite Element Analysis
263. Multivariable Control
283. Structural Dynamics

**Computer Science**
240. Computational Complexity
250. Numerical Analysis
252. Numerical Methods for Partial Differential Equations
264. Nonlinear Dynamics
270. Artificial Intelligence
271. Numerical Artificial Intelligence
350. Topics in Numerical Mathematics
364. Advanced Topics in Nonlinear and Complex Systems

**Earth and Ocean Sciences**
203. Physical Oceanography
207. Analysis of Coastal Engineering Models
221. Hydrogeology
222. New Perspectives and Methods in the Earth Sciences
223. Computational Methods in Hydrologic Sciences
230. Advanced Structural Geology
250. Applied Mathematics for the Environmental and Earth Sciences
252. Geophysics and Crustal Dynamics

**Electrical and Computer Engineering**
241. Linear Systems: Theory and Control
243. Pattern Classification and Recognition
255. Mathematical Modeling for Systems Analysis I
258. Artificial Neural Networks
263. Multivariable Control
281. Random Signals and Noise
282. Digital Signal Processing
285. Signal Detection and Extraction Theory
288. Image and Array Signal Processing
289. Adaptive Filters
299. Nonlinear Control Systems (Advanced Topics)
Mathematics
216. Applied Stochastic Processes
221, 222. Numerical Analysis
224. Scientific Computing I
225. Scientific Computing II
226. Topics in Numerical Analysis
228. Mathematical Fluid Dynamics
231. Ordinary Differential Equations
232. Partial Differential Equations I
233. Asymptotic and Perturbation Methods
239. Mathematical Modeling
281, 282. Partial Differential Equations II, III

Mechanical Engineering and Materials Science
202. Engineering Thermodynamics
209. Soft Wet Materials and Interfaces
210. Intermediate Dynamics
216. Mechanical Metallurgy
217. Fracture of Engineering Materials
221. Compressible Fluid Flow
225. Mechanics of Viscous Fluids
226. Intermediate Fluid Mechanics
227. Advanced Fluid Mechanics
229. Computational Fluid Dynamics and Heat Transfer
230. Modern Control and Dynamical Systems
231. Adaptive Structures
232. Optimal Control
235. Advanced Mechanical Vibrations
237. Aerodynamics
238. Advanced Aerodynamics
239. Unsteady Aerodynamics
252. Buckling of Engineering Structures
280. Convective Heat Transfer
290. Physical Oceanography
325. Aeroelasticity
331. Nonlinear Control Systems
335. Nonlinear Mechanical Vibration

Physics
213. Introductory Nonlinear Dynamics
230. Mathematical Methods in Physics
271. Quantum Optics
281. Classical Mechanics
303. Statistical Mechanics
304. Advanced Topics in Statistical Mechanics
313. Advanced Nonlinear Dynamics
318. Fundamentals of Electromagnetism
319. Advanced Electrodynamics

Nicholas School of the Environment and Earth Sciences
290. Physical Oceanography
356. Environmental Fluid Mechanics

Nursing

Professor Gilliss, Dean (3027A School of Nursing); Professor Davis, Program Chair and Director of Graduate Studies (3071A School of Nursing); Professors Anderson, Bernard, Champagne, Davis, Holditch-Davis, Gilliss, Johnson, Lipkus, Relf, Turner; Associate Professors Bailey, Barroso, Brandon, Goodwin, McConnell, Schneider; Assistant Professors Corazzini, Docherty, Hendrix, Knobel, Johnson, Price, Short, Thornlow, Wood, Vorderstrasse; Clinical Professors Lambe, Miller, Powell, Sullivan, Vacchiano, Valiga; Associate Research Professors Landerman, Silva; Assistant Research Professor Levy

The PhD Program in Nursing will prepare strong scientists to conduct nursing research in the broad area of Trajectories of Chronic Illness and Care Systems. Graduates will assume roles primarily in academic and research settings. Our approach is to admit a small number of highly qualified applicants so that every student will work closely with one or more faculty members in a series of mentored experiences, supported by formal course work, (a) to ensure socialization to the role of research scientist; (b) ensure significant knowledge and skill acquisition for launching a successful program of research post doctorate; and (c) to prepare for an entry level role in an academic setting.

The program requires a minimum of 57 credit hours of course work prior to a dissertation. Students will work on active research projects and it is expected that most will graduate with a record of publication. Course work is structured with a substantial core (39 credits) of nursing science and research methods to be taken in the School of Nursing. This core will be expanded with elected statistics, research methods, and minor area courses (18 credits) to be taken mainly outside of nursing in other Duke University departments. In addition to course work and a
dissertation, the PhD Program in Nursing will involve two program-long structured activities that include mentored research and teaching experiences and development of the student’s scholarly portfolio. Each student takes a comprehensive exam at the end of the second year or at the beginning of the third year of residence. The final requirement is the presentation of a dissertation. All students will be expected to complete the program in four to five years.

A baccalaureate or master’s degree in nursing from an accredited program (NLN or CCNE) is required for admission to the PhD Program in Nursing:

**Post-master’s students.** The student entering the PhD program with a master’s degree in nursing must show evidence of a master’s level nursing research course and a graduate statistics course. These prerequisites may be met by taking N307 (Research Methods) and N308 (Applied Statistics) before proceeding with PhD coursework (see Duke University School of Nursing Bulletin).

**Post-baccalaureate students.** The post-baccalaureate student will be admitted following demonstration of exceptional qualifications and clear research-oriented career goals. The student entering the PhD program post-baccalaureate must meet specific requirements. The post-baccalaureate students in the PhD program will declare a substantive focus area (e.g., gerontology, oncology, pediatric nursing, nursing and/or healthcare leadership). Eligible BSN applicants are expected to have completed a nursing research course, a graduate-level statistics course, and an advanced nursing role course (see the Duke University School of Nursing Bulletin).

For further program information please visit the School of Nursing Web site at: [http://www.nursing.duke.edu/](http://www.nursing.duke.edu/) or e-mail huppert@duke.edu.

**Nursing Courses (NURSING)**

**601. Philosophy of Science and Theory Development.** Focus is on the purposes of science, scientific process, and knowledge development as debated in current literature. Debates arising from different philosophic traditions (e.g., rationalism, empiricism) inform discussion about the nature of the nature of science and Nursing’s past, present, and future directions in theory and knowledge development. The student will apply knowledge gained to concept analysts and refinement and theory construction related to trajectories of chronic illness and care systems. Permission of department required. 3 units.

**602. Advanced Research Methods.** Focus is on principles of research design for human subject research. The course has two areas of emphasis: measurement issues in research and descriptive, quasi-experimental and experimental design characteristics. Topics covered include theory-testing versus theory-generating studies, hypothesis formulation, testing and statistical power, sampling stratification, treating and comparison groups and trajectory analysis are discussed. Consent of department required. 3 units.

**604. Statistical Analysis II: Categorical Data Analysis.** Focus is on the most important and commonly used regression models for binary, ordinal, and count outcomes. Topics include: estimating and interpreting regression coefficients, assessing model fit, and significance testing using logistic, Poisson, and negative binomial models. Explore nonlinear regression models to analyze both epidemiologic (survey) and clinical data. Assignments will provide the student with hands-on data analytic experience (with relevant SAS procedures) and with a workbook of specific examples that can be applied to the student’s subsequent research activities. Prerequisite: Statistical Analysis I: GLM (or equivalent). Permission of department required. 3 units.

**605. Longitudinal Methods.** Focus is on longitudinal research methods, including conceptualization, design, data management, and analysis. Assumptions and limitations of longitudinal statistics, particularly the general linear mixed model, generalized estimating equations, and survival modeling; relationship between design and analyses; and strategies to maintain scientific integrity are covered. Topics include estimating and interpreting coefficients in mixed models, assessing model fit, and significance testing using SAS procures. Assignments will provide the student with hands on data analytic experience (with relevant SAS procedures). Prerequisite: Statistical Analyses I and II or their equivalent. 3 units.

**606. Qualitative Research Methods.** Focus is on theoretical and methodological aspects of qualitative research methods. Discusses qualitative research approaches from a variety of disciplines and philosophical traditions, with emphasis on the application of research designs and data collection and analysis techniques to nursing studies. The relevance of these approaches to advancement of knowledge and practice in nursing and healthcare is explored. Permission of department required. 3 units.

**607A. Doctoral Seminar in Nursing Science I: Overview of Chronic Illness & Care System.** First semester of two-semester overview of science & research in chronic illness and care systems. This doctoral seminar will provide an overview of science and research on the trajectories of chronic illness and care systems. Fall topics will include an overview of the trajectories model, patterns of human responses to chronic illness, approaches to understanding trajectories and development, and the care systems with which individuals and groups interact to change illness trajectories. 3 units.

**607B. Doctoral Seminar in Nursing Science I: Overview of Chronic Illness & Care Systems.** Second seminar of a two-semester overview of science & research in chronic illness and care systems. Spring topics focus on the environmental and organizational context of chronic illness. Faculty and students will explore competing theoretical perspectives and consider how each would guide an empirical study in a specific research area. In addition, students will be introduced to DUSON research faculty and the research going on in the school. The seminar also addresses scholarly skill development including research synthesis, authorship, academic integrity, grant writing, and human subjects; issues with vulnerable populations. 3 units.
units.

**608A. Doctoral Seminar in Nursing Science II: Topics in Chronic Illness & Care Systems.** This doctoral seminar will provide in-depth study of selected topics related to trajectories of chronic illness and care systems. Topics will vary with the dissertation research interests of the PhD students and expertise of DUSON faculty. Examples of topics include disease prevention, symptom management; physical, emotional and cognitive function, fatigue/sleep, quality of life, informal caregiving (self and family) and care system interventions. The student examines and synthesizes critical theoretical, substantive, and methodological issues in preparation for the individualized qualifying examination to be taken at the end of second year or beginning of third year and writes a research literature synthesis paper that critiques design and measurement issues in the dissertation research area. Each student also will conduct a small-scale psychometric study of measures drawn from an existing dataset with relevance for the student's research area. Prerequisites: Nursing Science I. 3 units.

**608B. Doctoral Seminar in Nursing Science II: Topics in Chronic Illness & Care Systems.** This seminar will focus in 3 areas: how to conduct program evaluation research; the conduct of research in/with organizations; and research in the community for disease prevention and health promotion, with a focus on how to build community-based partnerships and research teams, the use of formative research in a community-based research projects, the development of community interventions and implementation, and evaluation methods for community-based projects. Emerging methods such as community based participatory action research, synergic methods, appreciative inquiry and critical theory/methods will be discussed. Prerequisites: N607A, N607B and N 608A. Consent of department required. Spring. Instructor: Staff. 3 units.

**609A. Doctoral Seminar in Nursing Science III: Dissertation.** First semester of a two semester course. In this doctoral seminar, the student will write the dissertation proposal. Topics for discussion will include theoretical, substantive and methodological issues in planning longitudinal research, mentored research experiences, and mentored teaching experiences. The student will write a data-based manuscript, based on the mentored research experiences, and submit for publication (may be done in collaboration with faculty and peers). Prerequisite: Nursing Science I and Nursing Science II. Permission of department required. 3 units.

**609B. Doctoral Seminar in Nursing Science III: Dissertation.** Second semester of a two semester course. In this doctoral seminar, the student will write the dissertation proposal. Topics for discussions will include theoretical, substantive and methodological issues in planning longitudinal research, mentored research experiences, and mentored teaching experiences. The student will write a data based manuscript, based on mentored research experiences, and submit for publication (may be done in collaboration with faculty and peers). Prerequisite: Nursing Science I and Nursing Science II. Consent of department required. 3 units.

**Pathology**

Professor Pizzo, Chair (301B Davison); Professor Abraham, Director of Graduate Studies (255 Jones); Professors Abraham, Bigner, Dewhirst, Dzau, Friedman, Greenberg, Hoffman, Jirtle, Klintworth, Patz, Pizzo, Proia, Shelburne, Staats, Sunday, Telen and Zalutsky; Associate Professors Hale, Kane, Kraus, Lawson, Marks, Nicchitta, Ortel, and Sempowski; Assistant Professors Bachelder, Datto, Devi, Feng, Freedland, Ramsburg and Yan

The PhD program in the Department of Pathology is designed to train students for research and teaching careers in molecular medicine and experimental pathology. Coursework aims to provide a clear understanding of disease processes, while focusing on modern molecular approaches to understanding and treating human disease. Research in the department covers the broad areas of inflammation, tumor biology, and vascular biology in a multidisciplinary fashion, involving both basic scientists and clinician researchers. Further information can be obtained from the director of graduate studies or from the departmental Web site at: pathology.mc.duke.edu.

**Pathology Courses (PATHOL)**

**220C. What Does A Pathologist Really Do?.** The major objective of this selective is to provide the student with answers to the following questions: a) What are the major areas that comprise the practice of pathology (Laboratory Medicine)? What is Anatomic Pathology? Clinical Pathology (Laboratory Medicine)? What are the recognized sub-specialties in pathology? b) How does the pathologist function as part of the health care team? What role does a pathologist play in clinical decision making? c) If you practice Internal Medicine / Surgery / Pediatrics / Ob-Gyn / Primary Care, what can the pathologist do for you? d) What is the pathologist's role as a teacher? Students will participate in several learning experiences (2-3 days each) that involve working with faculty and residents in various sub-disciplines of pathology [e.g., autopsy, surgical pathology (frozen section diagnostic service, specimen accessioning/gross descriptions service, diagnostic services), hematopathology/flow cytometry, neuropathology, dermatopathology, cytopathology/fine needle aspiration service, molecular diagnostics, cytogenetics, immunopathology/transplantation pathology, transfusion medicine, and others]. The exact set of experiences will depend on student interests, faculty availability, and number of students on the service. In each case, every attempt will be made to give the student the types of experiences that allow for fulfillment of the course objectives. Students will attend selected conferences and seminars and will meet with the course director (or representative) at least twice during the selective. The majority of learning experiences will be in the Department of Pathology at DUMC. A few are located at DVAMC and at the Franklin Park Clinical Laboratories. Enrollment Max. 4. Location: M345 Davison (Duke S.) at 8:30 a.m. Dr. Buckley requests that students be on time. Contact: please email Dr. Buckley at patrick.buckley@duke.edu should you have questions. Patrick Buckley, MD/PhD. 2 units.
225. Introduction to Systemic Histology. Organ system approach to microscopic identification of a variety of cell types and tissues in histologic sections. Emphasis on the histology of normal organs. Laptop computer and/or microscope required; contact instructor for specific information before registering. Consent of instructor required. Instructors: Hale and Staff. 2 units.

250. General Pathology. This is the medical school core course in pathology. Lectures deal with broad concepts of disease and underlying molecular mechanisms. Consent of instructor required. Instructor: Staff. 4 units.

275. Fundamentals of Electron Microscopy and Biological Microanalysis. Emphasis will be placed on preparative procedures including freezing techniques and on the application of electron microscopy to ultrastructural pathology. Scanning electron microscopy, X-ray microanalysis, and scanning ion microscopy will be discussed in addition to conventional transmission electron microscopy. Limited laboratory experience included. Consent of instructor required. Instructors: Ingram, Lefurgey, Roggli, and Shelburne. 3 units.

355. Graduate Seminar in Pathology. Graduate students in the Pathology program present their research in a formal presentation. Instructor: Abraham. 1 unit.

358. Research (Independent Study). Permission of department required. Instructor: Staff. 10 units.

385. Molecular Aspects of Disease. Background, investigative methods, and recent advances in understanding the molecular basis of selected diseases. In-depth focus on selected diseases whose defects are known at genetic or molecular levels. Prerequisites: introductory cell biology and biochemistry courses. Instructors: Yan and staff. 3 units.

Pharmacology and Cancer Biology
Professor Means, Chair (C238 LSRC); Professor Rathmell, Director of Graduate Studies (C238 LSRC); Professors Abou-Donia, Andrews, Arshavsky (Ophthalmology), Casey, Ehlers (Neurobiology), Heitman (Molecular Genetics and Microbiology), Kornbluth, Kuhn, Levin (Biological Psychiatry), Lew, McDonnell, McNamara (Neurobiology), Nadler, Newgard, Pendergast, Patz (Radiology), Schwartz-Bloom, Slotkin, Thiele, Wang; Associate Professors Blobe (Medicine), Counter, Haystead, Kirsch (Radiation Oncology), Kontos (Medicine), Kwatra (Anesthesiology) Pitt (Medicine), Rathmell, Rao (Ophthalmology), Reya, Seewaltdt (Medicine), Wechsler (Pediatrics), Wechsler-Reya, Whorton, Yao, J. York; Assistant Professors Macalpine, Muoio (Medicine), S. York; Medical Research Professor Wilson

Pharmacology is the science of drug action on biological systems. It encompasses the study of targets of drug action, the mechanisms by which drugs act, the therapeutic and toxic effects of drugs, as well as the development of new therapeutic agents. As the study of pharmacology is interdisciplinary, the graduate program in pharmacology is diverse and flexible. The focus of the graduate program in pharmacology is to prepare qualified individuals for a career in independent research. The Department currently has 24 primary faculty and 21 secondary faculty with primary appointments in departments such as molecular genetic and microbiology, cell biology, cardiology, medicine, and neurobiology. The collaborative and collegial atmosphere between faculty and students provides a wide diversity of research opportunities.

Pharmacology and Cancer Biology Courses (PHARM)

210. Research Independent Study in Science Education. Individual research in a field of science education (with reference to pharmacology) at the precollege/college level, under the supervision of a faculty member, resulting in a substantive paper or written report containing significant analysis and interpretation of study results. Open to all qualified seniors and graduate students with consent of supervising instructor. Instructor: Schwartz-Bloom. 3 units.

211. Research Independent Study in Science Education. Individual research in a field of science education (with reference to pharmacology) at the precollege/college level, under the supervision of a faculty member, resulting in a substantive paper or written report containing significant analysis and interpretation of study results. Open to all qualified seniors and graduate students with consent of supervising instructor. Instructor: Schwartz-Bloom. 3 units.

233. Essentials of Pharmacology and Toxicology. Drug absorption, distribution, excretion, and metabolism. Structure and activity relationships; drug and hormone receptors and target cell responses. Consent of instructor required. Prerequisite: introductory biology; Chemistry 151L; Mathematics 31 and 32. Instructor: Slotkin and staff. 4 units. C-L: Neuroscience 233

234. Interdisciplinary Approach to Pharmacology. Several model systems (cancer, immunological disorders, and infectious diseases) will be used to explore the molecular, biochemical, and physiological basis of drug action. Consent of instructor required. Instructors: Rathmell, Wang, or Whorton. 4 units.

235. Interdisciplinary Approaches to Pharmacology Part II. Several model systems (CNS, cardiovascular, and infectious diseases) will be used to explore the molecular biochemical, and physiological basis of drug action. Consent of instructor required. Instructor: Whorton. 4 units.

254. Mammalian Toxicology. Principles of toxicology as related to humans. Emphasis on the molecular basis for toxicity of chemical and physical agents. Subjects include metabolism and toxicokinetics, toxicologic evaluation, toxic agents, target organs, toxic effects, environmental toxicity, management of poisoning, epidemiology, risk assessment, and regulatory toxicology. Prerequisite: introductory biology, and Chemistry 151L, or consent of instructor. Instructor: Abou-Donia and staff. 4 units.

280. Student Seminar in Pharmacology. Preparation and presentation of seminars to students and faculty on topics of broad

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interest to pharmacology. Required of all pharmacology graduate students. Instructor: Wang and Thiele. 2 units.

For Graduate Students Only

314. Integrated Case Studies in Toxicology. 1 unit. C-L: see Environment 314
315. Focused Topics in Toxicology. 1 unit. C-L: see Environment 315

333. Statistics for Basic Biomedical Scientists. The use and importance of statistical methods in laboratory science, with an emphasis on the nuts and bolts of experimental design, hypothesis testing, and statistical inference. Central tendency and dispersion, Gaussian and non-Gaussian distributions, parametric and nonparametric tests, uni- and multivariate designs, ANOVA and regression procedures. Ethical issues in data handling and presentation. Student presentations in addition to formal lectures. Intended for third-year graduate students. Instructor: Slotkin. 2 units. C-L: Neurobiology 333, Cell and Molecular Biology 333

347. Seminar in Toxicology. 1 unit. C-L: Environment 367

348. Seminar in Toxicology. A weekly research seminar throughout the year is required of participants in the Toxicology Program. Students, faculty, and invited speakers present their findings. Instructor: Levin. 1 unit. C-L: Environment 348

364. Neurotoxicology. Adverse effects of drugs and toxicants on the central and peripheral nervous system; target sites and pathophysiological aspects of neurotoxicity; factors affecting neurotoxicity, screening and assessment of neurotoxicity in humans; experimental methodology for detection and screening of chemicals for neurotoxicity. Instructor: Abou-Donia and staff. 3 units. C-L: Neurobiology 364

372. Research in Pharmacology. Laboratory investigation in various areas of pharmacology. Credit to be arranged. Instructor: Staff. Variable credit.

417. Cellular Signaling. 3 units. C-L: see Cell Biology 417; also C-L: Biochemistry 417, Molecular Cancer Biology 417

418. Molecular Mechanisms of Oncogenesis. 2 units. C-L: see Molecular Cancer Biology 418

Philosophy

Professor Rosenberg, Chair (201 West Duke); Professor Neander, Director of Graduate Studies; Professors Brandon, Buchanan, Flanagan, Gillespie (political science), Golding, Grant (political science), Hoover, McShea (biology), Neander, Norman, Purves (neurobiology), Rosenberg, Schmaltz, Sreenivasan, and Wong; Associate Professors Ferejohn, Güzeldere, and Janiak; Assistant Professors Einheuser and Sterrett; Professors Emeriti MacIntyre, Peach, Sanford, and Welsh; Adjunct Associate Professor Ward; Associate Research Professor Hawkins; Senior Research Professor Dretske

The Department of Philosophy offers graduate work leading to the AM and PhD degrees.

Tutorial work complements formal instruction. Students may, after taking a balanced program, specialize in any of the following fields: the history of philosophy (from ancient to 20th century analytic), epistemology, metaphysics, philosophy of language, philosophy of mind, the philosophical foundation of cognitive science, moral psychology, normative ethics, metaethics, political philosophy, Chinese philosophy, philosophy of science, philosophy of biology, philosophy of social science, philosophy of law, philosophy of mathematics, and philosophical logic.

Individual programs of study are developed for each student. Prior to being admitted to candidacy for the PhD degree, the student must successfully complete fifteen courses distributed among five subject areas and pass an exam on a Future Research Statement and a preliminary examination on the dissertation proposal. In satisfying these requirements, students are expected to demonstrate both factual knowledge and critical understanding. Work in a minor or related field, not necessarily confined to any one department, is encouraged but not required.

If a student's dissertation is devoted to any considerable extent to an author, that student must be able to read the author's works in the original language/s. Reading knowledge is demonstrated by either (1) receiving at least a grade of "B" in French 2, German 2, Greek 2, Latin 2, or other language course that the Director of Graduate Studies has approved in advance, or (2) passing a departmentally administered translation exam.

The Philosophy Department considers for financial aid only students seeking the PhD degree. Almost all philosophy graduate students at Duke are either in the PhD program or in a joint-degree program, such as the JD/MA and JD/PhD programs. In exceptional cases, the department may admit someone to a master's program. A terminal degree of Master of Arts may also be earned by a PhD student who decides not to continue with doctoral studies and who meets the requirements of the Graduate School for the AM. Such a student must pass an oral master's examination, which may be the defense of a master's thesis or an alternative academic exercise approved by the department. JD/MA and JD/PhD degrees are offered by the department in cooperation with the Duke Law School. JD/MA students must apply for admission to the Law School, and JD/PhD students must apply for admission to both the Law School and the Graduate School. Both kinds of students must combine relevant course work in philosophy with full-time work toward a law degree.

For further information about the PhD or master's program in philosophy, please see or write to: Karen Neander, Director of Graduate Studies, Department of Philosophy, Box 90743, 201 West Duke Building, Duke University, Durham, NC 27708-0743, or e-mail her at kneader@duke.edu. Our Web site is: http://philosophy.duke.edu/. To inquire about the JD/MA and JD/PhD programs, applicants should contact the Law
School directly, at the following address: Associate Dean of Student Affairs, Duke Law School, Box 90376, Duke University, Durham, North Carolina 27708.

**Philosophy Courses (PHIL)**

**203S. Contemporary Ethical Theories (C-N).** The nature and justification of basic ethical concepts in the light of the chief ethical theories of twentieth-century British and American philosophers. Consent of instructor required. Instructor: Flanagan, Golding, or Wong. 3 units. C-L: Political Science 289S

**206S. Responsibility.** The relationship between responsibility in the law and moral blameworthiness; excuses and defenses; the roles of such concepts as act, intention, motive, ignorance, and causation. Instructor: Golding. 3 units.

**208S. Political Values.** Analysis of the systematic justification of political principles and the political values in the administration of law. Instructor: Golding. 3 units.

**211S. Plato.** Selected dialogues. Instructor: Ferejohn. 3 units. C-L: Classical Studies 211S

**217S. Aristotle.** Selected topics. Instructor: Ferejohn. 3 units. C-L: Classical Studies 217S

**218S. Medieval Philosophy.** Study of Augustine against background of late ancient Roman philosophy, and Thomas Aquinas and others against background of medieval Muslim philosophy, in particular Avicenna and Averroes, and Neoplatonism. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 218S

**225S. British Empiricism.** A critical study of the writings of Locke, Berkeley, or Hume with special emphasis on problems in the theory of knowledge. Instructor: Schmaltz. 3 units.

**227S. Continental Rationalism.** A critical study of the writings of Descartes, Spinoza, or Leibniz with special emphasis on problems in the theory of knowledge and metaphysics. Instructor: Schmaltz. 3 units.

**228S. Recent and Contemporary Philosophy.** A critical study of some contemporary movements, with special emphasis on analytic philosophers. Instructor: Sterrett. 3 units. C-L: Linguistics 228S

**229S. Topics in the History of Philosophy.** Topics in one or more periods in the history of philosophy (for example, ancient, medieval, or modern) such as skepticism, mind-body relations, the nature of persons and personal identity, the relation between physics and metaphysics, causation and explanation. Instructor: Flanagan, Ferejohn, Janiak, Rosenberg, Schmaltz, or Sterrett. 3 units.

**231S. Kant's Critique of Pure Reason.** Instructor: Janiak. 3 units.

**233S. Methodology of the Empirical Sciences.** Recent philosophical discussion of the concept of a scientific explanation, the nature of laws, theory and observation, probability and induction, and other topics. Consent of instructor required. Instructor: Brandon or Rosenberg. 3 units.

**234S. Problems in the Philosophy of Biology.** Selected topics, with emphasis on evolutionary biology: the structure of evolutionary theory, adaptation, teleological or teleonomic explanations in biology, reductionism and organismic, the units of selection, and sociobiology. Consent of instructor required. Instructor: Brandon, Neander, or Rosenberg. 3 units. C-L: Biology 234S

**236S. Hegel's Political Philosophy (C-N).** 3 units. C-L: see Political Science 236S; also C-L: German 275S

**237S. Nietzsche's Political Philosophy (C-N).** 3 units. C-L: see Political Science 226S; also C-L: German 276S

**238S. Problems in the Philosophy and Policy of Genomics.** An examination of normative, methodological, and metaphysical issues raised by molecular biology, and its relations to other components of biology, including human behavior. Instructor: Rosenberg. 3 units.

**240S. Philosophical Psychology.** A study of recent work on the nature of the self and the nature and function of consciousness. Work from philosophy, psychology, cognitive neuroscience, and evolutionary biology will be discussed. Instructor: Flanagan, Güzeldere, or Neander. 3 units.


**250S. Topics in Formal Philosophy.** Topics selected from formal logic, philosophy of mathematics, philosophy of logic, or philosophy of language. Instructor: Einheuser. 3 units.

**251S. Epistemology.** Selected topics in the theory of knowledge; for example, conditions of knowledge, skepticism and certainty, perception, memory, knowledge of other minds, and knowledge of necessary truths. Instructor: Dretske, Einheuser, or Sanford. 3 units.

**252S. Metaphysics.** Selected topics: substance, qualities and universals, identity, space, time, causation, and determinism. Instructor: Einheuser or Sanford. 3 units.

**255S. Topics in Philosophy of Mind.** One or more topics such as mental causation, animal minds, artificial intelligence, and foundations of cognitive science. Includes relevant literature from fields outside philosophy (for example, psychology, neuroscience, ethology, computer science, cognitive science). Instructor: Dretske, Güzeldere, or Neander. 3 units. C-L: Neuroscience 255S

**259. The Biological Basis of Music.** 3 units. C-L: see Neurobiology 259; also C-L: Psychology 265, Music 259
266S. Topics in Early Modern Political Thought from Machiavelli to Mills (C-N). 3 units. C-L: see Political Science 266S
270. Body Works: Medicine, Technology, and the Body in Early Twenty-first Century America. 3 units. C-L: see Information Science and Information Studies 270; also C-L: Literature 262
273S. Heidegger (C-N). 3 units. C-L: see Political Science 273S
238S. Problems in the Philosophy and Policy of Genomics. An examination of normative, methodological, and metaphysical issues raised by molecular biology, and its relations to other components of biology, including human behavior. Instructor: Rosenberg. 3 units.
291S. Special Fields of Philosophy. Instructor: Staff. 3 units.
292. Special Topics in Philosophy. Topics vary each semester. Instructor: Staff. 3 units.
292S. Bioethics. Course offers a graduate-level intro to bioethics. Topics include the history of bioethics; research ethics; limit setting in health care; and reproductive ethics. Course primarily intended for seniors and graduate students. Instructors Ross McKinney, Gopal Sreenivasan, and other faculty from the Trent Center for Bioethics, Humanities, and the History of Medicine. 3 units.

For Graduate Students Only
311. Philosophy and Medicine. The scope of medicine as a philosophical problem, the concept of health, and investigation of ethical issues arising in medical contexts. Consent of instructor required. Instructor: Golding. 3 units.
317S. The Evolution of Bioethics in the 20th Century. This course will address important themes in Bioethics and how they evolved through the 20th Century. Issues will include the ethical conduct of human subjects research (including study of misadventures like the Tuskegee syphilis project); contemporary thought regarding end-of-life decisions; the effect of advancing technology on ethical reasoning regarding pregnancy (prenatal genetic testing, the changing limits to viability of newborns, and attitudes toward abortion); research in children; and the issues of public health like quarantine and the right to refuse vaccination. Instructors: McKinney, Sreenivasan, Baker, Humphreys, Lyerly. 3 units.
335. Thinking About God. Analytical examination of bases for belief in God and possibility of After-life, relation between faith and reason, and interrelated issues concerning justification for content of religious belief. considers similarities and differences on these issues among Judaism, Christianity, and Islam. Instructor consent required. Instructor: Staff. 3 units.
359S. Principles in Cognitive Neuroscience I. 3 units. C-L: see Psychology 359S; also C-L: Neurobiology 349S
360S. Principles in Cognitive Neuroscience II. 3 units. C-L: see Psychology 360S; also C-L: Neurobiology 350S

Philosophy, Arts, and Literature
Professor Moi, Director of Graduate Studies
A certificate is available in this program.
Requirements:
This certificate does not originate in an existing department with a clearly defined body of knowledge to be mastered by all. It is an attempt to meld different disciplines by working on similar or connected questions.
• Five graduate level courses approved by the Steering Committee, taken two per semester. Each course must satisfy at least one of the following criteria:
  o Engages a specific art form in relation to a key philosophical or aesthetic concept.
  o Explores the nature of an art form and connects it to key philosophical or aesthetic concepts.
  o Examines the connection between philosophy and at least one other art form
  o Focuses on at least one writer/artist and connects them with philosophically informed reflection on the dynamics of form, meaning and/or performance
  o Focuses on at least one key work or number of works, connecting then with philosophically informed reflections on creativity, the nature of specific art forms, questions of historicity and creativity, ethics and aesthetics.
• Present a research paper at a workshop at Duke after completion of at least four of the graduate level courses required.
• Interdisciplinary experience. Students must take courses in a minimum of three different departments.
For more information, visit http://www.duke.edu/web/philartslit/.
Philosophy of Biology

Professor Robert Brandon, Director of Graduate Studies (209 West Duke)

A certificate is available in this program.

The Duke Center for the Philosophy of Biology offers a formal interdisciplinary graduate certificate in the philosophy of biology. The program draws upon course work and faculty from the Duke departments of biology and philosophy, as well as from those at the University of North Carolina at Chapel Hill and North Carolina State University. It is designed to enable students with substantial backgrounds in one of the two disciplines to learn about the major issues that animate research and scholarship on the intersections between biology and philosophy. The philosophy classes enable students to acquire experience in methods of philosophical analysis and to explore the broader philosophical background of problems in the philosophy of biology. The biology classes provide exposure to theoretical questions in biology that raise conceptual issues, to experimental methods and quantitative modeling with substantive and often unarticulated philosophical implications. Students generally apply to the program in their first or second years of doctoral study.

The interdisciplinary certificate will require at least two 200-level seminars in the Philosophy Department in philosophy of biology, at least two 200-level courses in Evolutionary and/or Developmental biology in the Biology Department; a directed reading class supervised by a faculty member in the Center for Philosophy of Biology, which eventuates in a capstone research paper; and regular participation in the philosophy of biology seminar over a two-year period. The certificate will have as prerequisites prior enrollment in at least one 100-level class in the philosophy of science or the philosophy of biology, and at least two courses in biology at the 100 level.

Requirements
Draws resources from Duke Philosophy and Biology departments, as well as from UNC-Chapel Hill and NCSU. Students enter the certificate program during first or second year of graduate work. Certificate prerequisites are:

• Prior enrollment in a minimum of one 100-level course in the Philosophy of Science, or Philosophy of Biology.
• Prior enrollment in at least two 100-level courses in Biology.

Additional requirements:
• Two 200-level seminars in Philosophy of Biology (Philosophy Dept.).
• Two 200-level courses in Evolutionary and/or Developmental Biology (Biology Dept.).
• Directed reading class supervised by a faculty member in the center.
• Capstone research paper.
• Regular seminar participation over a two-year period (Philosophy of Biology).

For more information, visit http://philosophy.duke.edu/graduate/other-degrees-certificates.

Photonics

Associate Professor Wax, Director of Graduate Faculty (2571 CIEMAS)

A certificate is available in this program.

The purpose of the Graduate Certificate Program in Photonics is to broaden the scope of the typical disciplinary graduate student education program. Students are encouraged to develop interdisciplinary and transferable sets of skills in their course work and research activities. The program is designed to accommodate both Masters of Science and PhD students who have been admitted to one of the participating departments. The certificate program helps to guide students toward this broad view by requiring the completing of a survey course entitled Introduction to Photonics; three courses from the approved course listing; one formal presentation in the Fitzpatrick Center Seminar Series; attend at least four Fitzpatrick Center Seminars a year (as documented by the student’s advisor); and if the student is pursuing a PhD, two members of the center should be on the PhD dissertation committee. For more information about the program, contact Bob Guenther, Box 90305, Duke University Fitzpatrick Center, Durham, NC 27708; (919) 660-5598.

Requirements:
• For PhD candidate, one member of the FIP must be on the PhD dissertation committee
• Certificate accommodates both terminal M.S. and PhD students who have been admitted to one of the participating departments (BME, ECE CS, MTH, CHM, MEM, PHY).
• Four photonics courses from the approved course listing, of which one course must be a qualified “Introductory Survey Course” (See Certificate Course List)
• One research presentation for the Fitzpatrick Institute Student Groups. The director of graduate studies will maintain list of approved student seminar series
Physics

Professor Gauthier, Chair (137B Physics); Professor Teitsworth, Associate Chair for Teaching; Professor Palmer, Director of Graduate Studies; Professors Aspinwall, Baranger, Behringer, Chang, Edwards, Gao, Gauthier, Goshaw, Greenside, Han, Howell, Johnson, Liu, Mueller, Oh, Palmer, Petters, Samei, Smith, Thomas, Tornow; Associate Professors Bass, Chandrasekharan, Curtarolo, Finkelstein, Kotwal, Kruse, Mehan, Plessier, Schoenberg, Scoolar, Springer, Teitsworth, Wu; Assistant Professors Arce, Duchler, Walter, Yasuda; Professors Emeriti Bilpuch, Evans, Fairbank, Meyer, Roberson, Robinson, Walker, Walter, Weller; Associate Research Professor Phillips; Assistant Research Professors Ahmed and Tonchev; Adjunct Professors Ciftan, Dutta, Everett, Guenther, Lawson, Skatrud, West; Adjunct Assistant Professor Daniels; Visiting Professors Brown, Krim; Visiting Associate Professor Hastings

The Department of Physics offers graduate work for students wishing to earn the PhD degree. In addition to a balanced program of basic graduate courses, the department offers specialized courses and seminars in several fields in which research is being done by faculty and staff. With the help of faculty advisors, students select a course program to fit their individual backgrounds and goals, often including work in a related field. Students are encouraged to begin research work early in their careers, normally not later than the end of the fall of their second year, when students complete most of their formal coursework. Active areas of research include experimental studies in atomic physics, accelerator physics, biophysics, condensed matter, high energy, nonlinear, nuclear, optics and photon-laser physics, as well as theoretical work in condensed matter, nonlinear, nuclear and particle physics, and string theory. In addition, the Physics Department is a major participant in the university-wide Center for Nonlinear and Complex Systems and the Center for Theoretical and Mathematical Science.

Physics Courses (PHYSICS)

201. Survey of Nonlinear and Complex Systems. Survey lectures by Duke experts active in CNCS research; regular attendance in the CNCS seminar series; and a weekly meeting to discuss the lectures and seminars. May be repeated once. Prerequisite: Physics 213. Instructor: Behringer. 2 units.


205. Introduction to Nuclear and Particle Physics. Introductory survey course on nuclear and particle physics. Phenomenology and experimental foundations of nuclear and particle physics; fundamental forces and particles, composites. Interaction of particles with matter and detectors. SU(2), SU(3), models of mesons and baryons. Weak interactions and neutrino physics. Lepton-nucleon scattering, form factors and structure functions. QCD, gluon field and color. W and Z fields, electro-weak unification, the CKM matrix, Nucleon-nucleon interactions, properties of nuclei, single and collective particle models. Electromagnetic and hadronic interactions with nuclei. Nuclear reactions and nuclear structure, nuclear astrophysics. Relativistic heavy ion collisions. Prerequisites: for undergraduates, Physics 211, 212; for graduate student, Physics 315, which may be taken concurrently. Instructor: Walter. 3 units.

211. Quantum Mechanics I. Experimental foundation, wave-particle duality, the Schroedinger equation and the meaning of the wave function, analytical and numerical solution of one-dimensional problems, formulation in terms of states and operators, angular momentum and spin, applications to the harmonic oscillator and hydrogen atom. Prerequisite: Mathematics 104 or 107 and Physics 143L. Instructor: Scholberg or Teitsworth. 3 units.

212. Quantum Mechanics II. Further development of quantum mechanics with applications. Topics include: perturbation methods (time-independent and time-dependent), path integrals, scattering theory, local density theory, elements of relativistic quantum mechanics, and miscellaneous examples drawn from atomic, condensed matter, particle, and nuclear physics. Prerequisite: Physics 211. Instructor: Finkelstein. 3 units.

213. Nonlinear Dynamics. Introduction to the study of temporal patterns in nonequilibrium systems. Theoretical, computational, and experimental insights used to explain phase space, bifurcations, stability theory, universality, attractors, fractals, chaos, and time-series analysis. Each student carries out an individual research project on a topic in nonlinear dynamics and gives a formal presentation of the results. Prerequisites: Computer Science 6, Mathematics 107, and Physics 41L, 42L, or equivalent. Instructor: Behringer or Virgin. 3 units. C-L: Computer Science 264

214. Biophysics in Cellular and Developmental Biology. Application of the experimental and theoretical methods of physical sciences to the investigation of cellular and developmental systems. Topics include the physical techniques for investigating biological organization and function as well as examples of key applications. Prerequisites: Calculus-based introductory physics, Biology 119 or equivalent or consent of instructor. Instructor: Buchler. 3 units. C-L: Biology 214

217S. Advanced Physics Laboratory and Seminar. Experiments involving the fields of electricity, magnetism, heat, optics, and modern physics. Written and oral presentations of results. Instructor: Ohl. 3 units.

222. Special and General Relativity. Review of special relativity; ideas of general relativity; mathematics of curved space-time; formation of a geometric theory of gravity; Einstein field equation applied to problems such as the cosmological red-
shift and blackholes. Prerequisite: Physics 181 and Mathematics 107 or equivalents. Instructor: Plesser. 3 units.

230. Mathematical Methods in Physics. Includes topics in complex analysis, residue calculus, infinite series, integration, special functions, Fourier series and transforms, delta functions, and ordinary differential equations; and use of MATHEMATICA for graphical, symbolic, and numerical computation. Prerequisite: Mathematics 107. Instructor: Staff. 3 units.


246S. Selected Topics in Theoretical Physics. Topics vary as indicated on Physics Department Web site. Consent of Instructor required. Instructor: Staff. 3 units.

265. Advanced Optics. This course presents a rigorous treatment of topics in Photonics and Optics targeted at students with an existing photonics or optics background. Topics will include, Optical Sources, Statistical Optics and Coherence Theory, Detection of Radiation; Nonlinear Optics; Waveguides and Optical Fibers; Modern Optical Modulators; Ultrafast lasers and Applications. These topics will be considered individually and then from a system level perspective. Prerequisite: ECE 122 or equivalent. Instructor: Gauthier. 3 units. C-L: Electrical and Computer Engineering 221, Biomedical Engineering 238

271. Quantum Optics. The linear and nonlinear interaction of electromagnetic radiation and matter. Topics include lasers, second-harmonic generation, atomic coherence, slow and fast light, squeezing of the electromagnetic field, and cooling and trapping of atoms. Prerequisite: Physics 212 and 230. Instructor: Gauthier. 3 units.

272. Quantum Information Science. 3 units. C-L: see Electrical and Computer Engineering 227

281. Classical Mechanics. Newtonian, Lagrangian, and Hamiltonian methods for classical systems; symmetry and conservation laws; rigid body motion; normal modes and forced oscillations; small nonlinear oscillations; canonical transformations; Hamiltonian chaos. Instructor: Staff. 3 units.

292. General Relativity. This course introduces the concepts and techniques of Einstein's general theory of relativity. The mathematics of Riemannian (Minkowskian) geometry will be presented in a self-contained way. The principle of equivalence and its implications will be discussed. Einstein's equations will be presented, as well as some important solutions including black holes and cosmological solutions. Advanced topics will be pursued subject to time limitations and instructor and student preferences. Prerequisite: A familiarity with the special theory and facility with multivariate calculus. Instructor: Plesser or Aspinwall. 3 units. C-L: Mathematics 236

293. Representation Theory. 3 units. C-L: see Mathematics 253

For Graduate Students Only

301. Mathematical Methods of Physics. Includes topics in probability theory, complex analysis, asymptotic expansions, group theory, Fourier analysis, Green functions, ordinary and partial differential equations; and use of Mathematica. Instructor: Palmer. 3 units.


304. Advanced Topics in Statistical Mechanics. This course will vary from year to year. Possible topics include Fermi liquids, systems of bosons, many-body theory, nonequilibrium statistical mechanics. Prerequisite: Physics 303 and 316. Instructor: Behringer. 3 units.


306. Radiation Detection. Introduction to detection of charged particles, photons and neutrons. Emphasis on active detector techniques: ionization detectors, scintillators and semiconductors; some passive methods mentioned. Quick review of radiation interaction with matter, followed by general detector characteristics, practical measurement techniques, signal processing and brief overview of radiation protection. Prerequisite: Core courses in graduate physics program. Instructor: Staff. 3 units.

307. Introduction to Condensed Matter Physics. Microscopic structure of solids, liquids, liquid crystals, polymers, and spin systems; elastic scattering and long-range order; topological defects; electronic structure of crystals (metals and semiconductors); phonons and inelastic scattering; magnetism; superconductivity. Prerequisite: Physics 203, 211, 212. Instructor: Finkelstein. 3 units.

310. Advanced Solid-State Physics. Advanced energy band theory; Fermi liquid theory; many-body Green functions and
diagrammatic techniques; interacting electron gas; superconductivity; applications. Prerequisite: Physics 307 or equivalent. Instructor: Baranger. 3 units.

311. Electrodynamics. Maxwell’s equations, special relativity, covariant formulation of electrodynamics, conservation laws, electrostatics, magnetostatics, boundary conditions, electromagnetic induction, electromagnetic waves, and elementary radiation theory. Instructor: Yu. 3 units.

312. Quantum Mechanics. Angular momentum and symmetries in quantum mechanics from group theory viewpoint; time-independent and time-dependent perturbation theory; path integral formulation; scattering theory; identical particles; applications. Instructor: Springer. 3 units.

313. Advanced Topics in Nonlinear and Complex Systems. Survey of current research topics that may include: advanced signal analysis (wavelets, Karhunen-Loeve decomposition, multifractals), bifurcation theory (amplitude and phase equations, symmetry breaking), spatio-temporal chaos, granular flows, broken ergodicity, complexity theory of dynamical systems, and adaptive systems (genetic algorithms, neural networks, artificial life). Emphasis on quantitative comparisons between theory, simulations, and experiments. Not open to students who have taken Computer Science 313. Prerequisite: Computer Science 264 or Physics 213; recommended: Physics 230, 203, or equivalent. Instructor: Greenside. 3 units. C-L: Computer Science 364

315. Advanced Quantum Mechanics I. Third semester of graduate quantum mechanics sequence. Angular momentum and symmetries in quantum mechanics from group theory viewpoint; formal scattering theory; many body quantum mechanics; identical particles; path integral applications; quantization of electromagnetic field; relativistic treatment of spin-1/2 particles. Prerequisite: PHY 211 and PHY 212 or equivalent. Instructor: Springer. 3 units.

318. Fundamentals of Electromagnetism. Electrostatics, Laplace's equation, multipole expansion, dielectrics, magnetostatics, magnetization, Maxwell equations, gauge transformations, electromagnetic waves, Fresnel equations, and waveguides. Prerequisite: Physics 182 or equivalent and 213. Instructor: Palmer. 3 units.


321. Introduction to Accelerator Physics. Aspects of modern accelerator physics; operation of a variety of accelerators from electron microscopes to large ring machines; phenomena responsible for stability and instability of particle beams. Prerequisite: Physics 281, 318 or equivalents. Instructor: Wu. 3 units.

341. Quantum Field Theory. Classical field theory, symmetries and conservation laws, representations of the Lorentz Group, canonical quantization, Feynman diagrams and perturbation theory, elementary quantum electrodynamics, radioactive corrections, renormalization. Prerequisite: Physics 211, 212 and 315. Instructor: Staff. 3 units.

342. Advanced Quantum Field Theory. Study of a variety of topics in quantum field theory, selected from nonabelian gauge theory, anomalies, instantons, super-symmetry, topological defects, large-N techniques, spontaneous symmetry breaking, effective potentials, and finite temperature methods. Prerequisite: Physics 341. Instructor: Staff. 3 units.

346. Topics in Theoretical Physics. Topics vary; check Physics Department Web site. Consent of instructor required. Instructor: Staff. 3 units.

351. Physics Research Seminar. Series of weekly presentations on research projects under investigation in the department. Credit/No credit grading only. Instructor: Chandrasekharan. 1 unit.

352. Seminar Techniques. Discussion of ways of presenting seminars and participating in follow-on question periods. Each student is required to present at least one seminar on an appropriate research topic. Instructor: Staff. 1 unit.

361. Physics of Free-Electron Lasers. Seminar course on the basic physical mechanisms and effects responsible for emission and amplification of radiation by electron beams moving through transverse fields. Prerequisite: Physics 316 and 319. Instructor: Wu. 3 units.

391. Mini-Course on Current Research in Physics. One-third semester mini-course covering selected topics of current research in Physics. Topics course. Instructor: Staff. 1 unit.

392. Mini-Course on Methods for Physics Research. One-third semester mini-course covering selected experimental, computational, and/or theoretical methods used in physics research. Topics course. Instructor: Staff. 1 unit.

Political Science

Professor Remmer, Chair; Professor Wibbels, Associate Chair; Professor Ward, Director of Graduate Studies; Professors Aldrich, Feaver, Fish, Gelpi, Gillespie, Grant, Grieco, Hamilton (public policy), Horowitz (law), Hough, Jentleson (public policy), Kitschelt, Knight, Kuran (economics), Lange, McClain, Mickiewicz (public policy), Munger, Niou, Paletz, Price, Remmer, Rohde, Rosenberg (philosophy), Spragens, Ward; Associate Professors deMarchi, Eldridge, Hacohen (history), Haynie, Hillygus, Mayer (public policy), McKeown, Shi, Wibbels; Assistant Professors Beramendi, Bermeo (public policy), Büthe, Charney (public policy), Downes, Goss (public policy), Kelley (public policy), Krishna (public policy), Leventoglu, Siegel (law), Trejo; Research Professors Brennan, Euben, Keech, Soskice; Professors Emeriti Elrige, Hall, Holsti, Johns, Kornberg; Adjunct Professors Engstrom, MacKuen, Rabinowitz, Stimson, Vanberg; Associate Professor of the Practice Maghraoui

The Department of Political Science offers graduate work leading to the AM and PhD degrees.
Instruction is designed to prepare the student primarily for teaching and research. Instruction is currently offered in the following fields: American government and politics, comparative government and politics, international relations, political methodology, and political theory.

The candidate for the degree of Doctor of Philosophy in political science must take at least 12 courses in all, and demonstrate competence in at least two general fields of the discipline by taking three courses in each field. The candidate must also fulfill a statistics and/or foreign language requirement, and write a satisfactory dissertation.

The terminal degree of Master of Arts, for those who do not intend to continue with doctoral studies, is awarded following successful completion of: (1) eight one-semester courses of 3 units each, at least half of which must be in political science; (2) two other courses of 3 units each or 6 units of ungraded research; 3) complete and defend a thesis. In addition, candidates for the degree must demonstrate competence in one foreign language or in statistics.

These requirements for the degree apply both to students enrolled in the terminal program and to students originally enrolled in the PhD program who decide to end their involvement in the PhD program with a terminal degree.

Further details on the graduate program in political science, the departmental facilities, the staff, and available financial aid may be obtained from the Director of Graduate Studies, Department of Political Science.

Related Course Work In The School Of Law

Students at the School of Law earning a MA degree in Political Science along with the JD degree may take four courses (twelve credits) in Political Science as part of their required 84 credits for the JD To be eligible to receive the MA, they must complete four additional courses in Political Science, for a total of eight, and complete and defend a thesis. The courses chosen must be approved by the director of graduate studies. Further details on the program in political science may be obtained from the director of graduate studies, Department of Political Science.

Political Science Courses (POLSCI)

201S. Problems in International Security (D). The impact of democratic political structures on state foreign policy behavior. Emphasis on the influence of democratic norms and principles on the use of force. Theoretical debates on the influence of democracy and the use of force, with attention to the methodological and statistical difficulties of both measuring democracy and estimating its impact on international politics. Prerequisite: a course in international relations or American foreign policy. Instructor: Staff. 3 units.

202S. Race in Comparative Perspective (A). Comparative study of the way race is socially constructed in the United States, several European, Latin American, and other countries. The real effects of this social construction on the social and political lives of communities of color in these countries. Instructor: McClain. 3 units.

203S. Politics and Media in the United States (A). The impact of the media of communication and new technologies on American political behavior, government, politics, issues and controversies. Development of critical interpretive skills and arguments as students write research papers assessing the media's political influence and effects. Instructor: Paletz. 3 units.

205S. Collective Action, Property Rights, and the Environment (B). The rational choice tradition (public goods, collective action, game theory, property rights, new institutionalism) as applied to environmental problems, resource exploitation, environmental justice, and the design of an environmentally sound society. Instructor: McKean. 3 units.

206S. Political Participation: Comparative Perspectives (B). The study of political participation through development of an understanding of relevant research methods. The effects of political culture on political participation. Popular participation and mobilization systems in liberal democracies and developing countries. Instructor: Shi. 3 units. C-L: International Comparative Studies 201AS

207S. Religion and Comparative Politics (B). The relationship between states, societies, and religious institutions in contemporary world politics. Theories that emphasize the explanatory role of religious ideas, religious market structures, and different socio-economic and political conditions. Major focus on Christianity (Catholicism, Protestantism and Evangelicalism) mostly in Latin America, Western and Central Europe, and the United States. Attention also to Islam and Hinduism in Africa, the Middle East, and India. Instructor: Trejo. 3 units.

208S. Theories of International Conflict (D). Social science literature review of the causes of international conflict emphasizing the theories concerning the causes of war. Objectives of course: to identify the strengths and weaknesses of the literature concerning the causes of war; to define specific questions and issues which must be addressed by future research; and to develop concrete research strategies for investigating these questions. Instructor: Gelpi. 3 units.

209. Computational Political Economy (C-E). Introduction to the field of computational modeling. Emphasis on conducting formal replicable investigations of political phenomena with clearly defined assumptions and hypotheses. Study of current literature in cognitive psychology, political psychology, and experimental economics. Instructor: DeMarchi. 3 units.

209S. Post War Europe, 1945-1968: Politics, Society and Culture. 3 units. C-L: see History 204S

210S. Comparative Ethnic Politics. Why and when ethnicity becomes a salient cleavage for political mobilization and the conditions under which ethnic collective action may take violent or non-violent forms. Approaches to the study of social identities; types of ethnic collective action, including non-violent (electoral participation and social protest) and violent ones (riots, rebellions, civil war, and terrorism); and main normative debates in favor and against ethno-cultural group rights. Comparisons include Latin America, Africa, Europe, and South Asia. Instructor: Trejo. 3 units.
211S. Thucydides and the Realist Tradition (D). Focus on Thucydides as a foundational text in the international relations tradition of realism. Issues include human nature; the relationship between self-interest and moral norms; conceptions of power; and motivations of justice. Readings will include Thucydides' History, selections from Hobbes' Leviathan, evidence from the post-Napoleonic and post-World War I periods, and modern interpretive studies. Instructor: Lewis. 3 units.

212S. Politics and Markets (A, C-E, D). Seminar on classics of political economy, exploring the relationship between economic markets and politics as treated in the works of Adam Smith, Marx, Polanyi, Schumpeter, Lindblom, and Hirsch, as well as contemporary works on globalization and its effects on domestic politics. Open only to seniors and graduate students. Instructor: Staff. 3 units.

213S. Theories of International Political Economy (D). Issues include politics of trade, finance, economic development, conflict and cooperation in the world economy, and causes and consequences of economic globalization. Both advanced industrialized and developing countries. Open to qualified seniors with consent of instructor. Instructor: Buthe. 3 units.

214S. Economy, Society, and Morality in Eighteenth-Century Thought (C-N). Explorations of eighteenth-century topics with a modern counterpart, chiefly (a) self-interest, liberal society, and economic incentive; and (b) the passions, sociality, civic virtue, common moral sensibilities, and the formation of taste and opinion. Original texts: for example, Bacon, Newton, Shaftesbury, Mandeville, Hutcheson, Hume, Smith, Hogarth, Burke, Cato's Letters, Federalist Papers, Jane Austen. Stress on integrating economic and political science perspectives. Open only to seniors majoring in either political science or economics. Not open to students who have had Economics 146. Pre-requisites: Economics 105D; and Economics 110D. Instructors: De Marchi and Grant. 3 units. C-L: Economics 214S

215S. Democratic Institutions (B). How constitution makers choose basic rules of the democratic game, such as the relations between legislatures and executives, the role of parties, electoral system, prerogatives of constitutional courts, and other important elements of democratic institutional design; the impact of such arrangements on various groups within the state, and the overall performance of democracies; durability of arrangements, the structuring of power relations among parties, and whether democratic institutions affect economic and social policy outcomes. Instructor: Kitschelt. 3 units.

217. Minorities and Election Law. The course will cover issues of minority disfranchisement and minority vote dilution through administration of elections and the manner in which electoral competition is structured. Examines alternative ways to conduct elections and determine winners. Emphasis on ways in which courts respond to these issues and remedial alternatives. Instructor: Engstrom. 3 units.

216S. Gender, Identity, and Public Policy. 3 units. C-L: see Public Policy Studies 211S; also C-L: Women's Studies 211S

218S. Political Thought in the United States (A, C-N). American political thought and practice through the Civil War period. A critical analysis of the writing of our founders and their European antecedents. Focus on the philosophical and political debates and the underlying ethical and political issues found in the debates over the Constitution, slavery, and the Union. Instructor: Gillespie or Grant. 3 units.

219S. American Grand Strategy. Study of policy that nations adopt to marshal their political, economic, military, technological, and diplomatic resources to achieve their national goals in the international environment they face, drawing on political science, history, public policy, law and political economy and other disciplines to achieve these ends. Course examines the history, current reality, and future prospects of American grand strategy. Consent of instructor required. Instructor: Feaver. 3 units. C-L: History 220S, Public Policy Studies 219S

220S. Problems in International Politics (D). The development and critical analysis of various models in political science and economics that focus on the relationship between international economics and international security. Various models of the impact of political-military dynamics on international economic relationships, and the impact of international economics on the likelihood of war and peace among nations. Attention to the interplay between economics and security in a key region of the world--East Asia. Prerequisite: one course in international relations, foreign policy, or diplomatic history. Instructor: Staff. 3 units.

221S. Theories of International Relations (D). Systematic evaluation of major theories of international relations, including realism, liberalism, and constructivism. Identification of key criteria for assessment of theories, and discussion of new research frontiers in the field, including analysis of domestic politics and foreign policy. Instructor: Downes and Grieco. 3 units.

222. Introduction to Statistical Analysis (C-E). Basic applications of statistical theory to political questions: research design, hypothesis tests, computer data analysis. Consent of instructor required for undergraduates. Instructor: De Marchi. 3 units.

223. Ancient Political Philosophy (C-N). Intensive analysis of the political philosophy of Plato, Aristotle, and other ancient theorists. Research paper required. Instructor: Gillespie or Grant. 3 units. C-L: Classical Studies 203

224S. Modern Political Theory (C-N). A historical survey and philosophical analysis of political theory from the beginning of the seventeenth to the middle of the nineteenth century. The rise of liberalism, the Age of Enlightenment, the romantic and conservative reaction, idealism, and utilitarianism. Instructor: Grant or Spragens. 3 units.

225S. Understanding Ethical Crisis in Organizations. 3 units. C-L: see Study of Ethics 202S; also C-L: Sociology 202S, Public Policy Studies 203S

226S. Nietzsche's Political Philosophy (C-N). Study of the thinker who has, in different incarnations, been characterized as the prophet of nihilism, the destroyer of values, the father of fascism, and the spiritual source of postmodernism. An examination of his philosophy as a whole in order to come to terms with its significance for his thinking about politics.
Instructor: Gillespie. 3 units. C-L: German 276S, Philosophy 237S

228S. International Democratization. 3 units. C-L: see Public Policy Studies 228S

229S. Contemporary Theories of Liberal Democracy (C-N). Reading and discussion of some of the most important theoretical conceptions of democratic ideals and purposes since 1970. Topics include social justice, individual rights and community, deliberative democracy, and the normative implications of moral and religious pluralism. Instructor: Spragens. 3 units.

230S. Introduction to Positive Political Theory (C-E). Introduction to formal models in political science and a field of research that is at various times called political economy, positive political theory, formal theory, and public choice. Focus on three basic models that form the foundation of the field: individual choice, game theory, and social choice. Not open to students who have taken POLSCI 139. Instructor: Aldrich or Nioou. 3 units.

231S. Crisis, Choice, and Change in Advanced Democratic States (B). Contributions of Marx, Weber, and Durkheim toward analysis of modern democracies. Examination of selected contemporary studies using these three perspectives to highlight processes of change and crisis. Unsettling effects of markets upon political systems, consequences of bureaucratic regulation, and transformation of sources of solidarity and integration in modern politics. Instructor: Kitschelt. 3 units.

232S. Rule of Law (A). An investigation, employing both historical and conceptual analysis, of the idea of the rule of law. Several classic and contemporary texts will be considered. Topics include: the nature of law; the relationship between law and morality; the relationship between the rule of law and politics; the role, if any, of the rule of law in facilitating social and economic development; and the ways in which the rule of law might be institutionalized in modern society. Permission of instructor required. Instructor: Knight. 3 units.

233L. Intermediate Statistical Methods (C-E). Applications of regression models of politics emphasizing the effect of assumptions behind Generalized Least Squares regression. Prerequisite: Political Science 222; consent of instructor required for undergraduates. Instructor: Munger. 3 units.

234. 9/11: Causes, Response & Strategy. 3 units. C-L: see Public Policy Studies 233

236S. Hegel's Political Philosophy (C-N). Within context of Hegel's total philosophy, an examination of his understanding of phenomenology and the phenomenological basis of political institutions and his understanding of Greek and Christian political life. Selections from Phenomenology, Philosophy of History, and Philosophy of Right. Research paper required. Instructor: Gillespie. 3 units. C-L: Philosophy 236S, German 275S

238S. Courts, Wars, Legacies of Wars (A). The impact of international wars, international policing, and domestic wars relating to national security on the United States courts of the Fourth Circuit (Maryland, Virginia, West Virginia, North and South Carolina), and the role played by these courts in the Mid-Atlantic South from the American Founding into the Cold War Era. The American Constitution, laws, and treaties of the United States, and principles of admiralty and international law which figure in assigned published and unpublished judicial decisions of the region's United States district and old circuit courts and of the post-1891 Fourth Circuit Court of Appeals. Research paper required. Also taught as Law 548S. Instructor: Fish. 3 units. C-L: History 255AS

239S. American Mass Political Behavior. Several facets of the political behavior of mass actors in American politics. Likely topics include the factors that cause the type and amount of individual participation, mobilization by elites, ideology and information, partisanship, partisan stability and change, socialization, macro-level change, negative advertising, economic voting, issue evolution, and the effects of institutional changes (especially election rules) on voter turnout. Consent of Instructor required. Instructor: Aldrich. 3 units.

240S. The Politics of European Integration (D). Politics and institutions of the European Union (EU) and the historical process that led to it. Theoretical perspectives discussed include classics of integration theory (neofunctionalism, intergovernmentalism) but also theories of state formation, delegation, and distributional politics (EU comparatively as instance of common political phenomena). Social constructivist, gender, and Marxist theories also considered. Research papers on process of European integration or contemporary EU politics. Consent of instructor required. Instructor: Buthe. 3 units.

243S. Introduction to Deductive & Analytical Approaches to Political Phenomena. Introduction to deductive and analytical approaches currently used to study political phenomena, with focus on fundamentals of non-cooperative game theory. Students will become good consumers of applied game theoretic research as well as be able to develop some simple game theoretic models of political phenomena. Required of all incoming graduate students. Instructor: Staff. 3 units.

244S. Formal Modeling In Political Science (C-E). Emphasis on use of formal analysis in various subfields in political science. Students expected to (i) derive/prove the results from the readings, (ii) analyze the contribution of readings and (iii) find ways to improve the line of research. Students expected to have taken a course in game theory, Political Science 243S or equivalent. Instructor: Leventoglu. 3 units.

245. Counterterrorism Law and Policy. 3 units. C-L: see Public Policy Studies 245

246S. Political Economy of Growth, Inflation, and Distribution (A,B). Study of three kinds of economic performance: growth, inflation and distribution. Consider alternative policies, such as import substitution industrialization and neoliberalism, inflation targeting and exchange rates; alternative institutions, such as authoritarianism, competitive elections, limitation on government, central bank independence; and alternative histories, such as independence or colonial heritage. Instructor: Keech. 3 units. C-L: Economics 247S
247. Politics and Philosophy of Self and Other (C-N). Epistemological, ontological, ethical, and political dimensions of relations between self and other. Theorists may include Husserl, Merleau-Ponty, Levinas, Derrida, Adorno, Gadamer, Sartre, Foucault, and Bahktin. Instructor: Lange. 3 units.

248S. Contemporary Continental Political Thought (C). Exploration and assessment of the major theories (critical theory, hermeneutics, post-structuralism) and thinkers (Adorno, Habermas, Gadamer, Foucault, Derrida) of European political thought from World War II to the present. Themes addressed include alienation, power, liberation, social construction of identity. Research paper required. Instructor: Staff. 3 units.


252S. The Nation-State and the International System (D). The interaction between state structures and the international system, with a focus on the rise and development of European nations. Topics include war and its effects on national political institutions, nationalism, and state formation; war and national revolution; imperialism and decolonization; and economic dependency and national autonomy. Research paper required. Prerequisite: Political Science 93. Instructor: Grecco. 3 units.

255S. State and Society in China (B). An examination of selected aspects of Chinese politics. Prerequisite: Political Science 117 or equivalent. Instructor: Shi. 3 units.

256S. Theory and Practice of National Security (D). In-depth look at the theoretical and empirical literature explaining how states seek to guarantee their national security. Topics include: grand strategy, nuclear deterrence and warfighting, coercive diplomacy, military intervention, decisions for war, and civil-military relations. Special attention paid to U.S. national security during and after the Cold War. Consent of instructor required. Instructor: Feaver. 3 units.

257S. Politics, Society and Development in China (B). Issues affecting development in China including financial markets, labor, capital, democracy, and cultural patterns. Instructor: Shi. 3 units.

259S. American Civil-Military Relations (A, D). Theory and practice of relations between the military, society, and the state in the U.S. Special attention paid to how civil-military relations play out in the use of force. Other topics include: public opinion, casualty sensitivity, and the role of the military in partisan politics. Consent of instructor required. Instructor: Feaver. 3 units.

260S. Social Theory and Social Practice (C-N). Comparison and critique of answers given by philosophers and social theorists to the questions: what can we know about society and what is the practical utility of that knowledge? Theorists and topics include Aristotle, early modernity's "new science of politics," Marxist praxis, Weber's "weltfreet" science, Mill's logic of the "moral sciences," Comte's sociology, Mannheim's sociology of knowledge, behaviorism and its critics, the vocation of social science. Instructor: Spragens. 3 units.

264. Marine Policy (A). 3 units. C-L: see Environment 276; also C-L: Public Policy Studies 297

266S. Topics in Early Modern Political Thought from Machiavelli to Mills (C-N). Topics vary from semester to semester. Topics course. Instructor: Staff. 3 units. C-L: Philosophy 266S

267S. Persistence and Change in Political Institutions (B, D). Persistence and Change in Political Institutions (B,D). International and domestic institutions in world politics; focus on causes and mechanisms of institutional persistence and change in comparative perspective. Examines, for instance, evolution of political-economic institutions under the impact of globalization. Instructor: Buthe. 3 units.

268S. The Regulatory Process (A). 3 units. C-L: see Public Policy Studies 269S

271S. International Environmental Regimes (B, D). Law, politics, and institutional design of international regimes created among nations to cope with environmental problems. Includes study of particular conventions and treaties (for example, acid rain, ozone, carbon reduction, biodiversity, Antarctica, regional seas, ocean dumping), and the environmental implications of international trade rules and regimes (for example, GATT). Instructor: McKean. 3 units. C-L: Public Policy Studies 258S, International Comparative Studies 201CS

272S. International Relations Theory and Chinese Foreign Policy (B, D). Examines range of theories and conceptual approaches to the study of international relations to see how these may or may not work in explaining Chinese foreign policy and whether or not patterns of Chinese foreign policy require evaluation of theories. Instructor: Shi. 3 units.

273S. Heidegger (C-N). An examination of the philosophy of Martin Heidegger from its phenomenological beginnings to its postmodernist conclusions with particular attention to its meaning for questions of identity, history, nihilism, technology, and politics. Instructor: Gillespie. 3 units. C-L: Philosophy 273S

275. The American Party System (A). Role of political parties and the party system in the origin and perpetuation of democratic politics. Critical evaluation of different theories and models of the origins, structures, and activities of American political parties and their contribution to maintenance of a democratic society. Development of original research or critical evaluation of research findings using an extensive array of evidence, including statistical estimation and formal modeling. Instructor: Aldrich. 3 units.

276. Media in Post-Communist Societies (B). 3 units. C-L: see Public Policy Studies 243; also C-L: Russian 246

277. Comparative Party Politics (B). The concepts, models, and theories employed in the study of political parties in various competitive democracies. Focus on advanced industrial democracies where there is a rich empirically oriented literature on this topic. The resurgence of democracy in developing areas and the role of party competition and democracies in these regions of the world. Instructor: Lange. 3 units. C-L: International Comparative Studies 201E

279S. Contemporary United States Foreign Policy. 3 units. C-L: see Public Policy Studies 279S

300. Comparative Legislative Politics (B). Analysis of legislative politics in comparative perspective. Designed for seniors and graduate students. Instructor: Staff. 3 units. C-L: International Comparative Studies 202A

281S. Collective Action and Social Movements (B). Seminar course will introduce students to two dominant paradigms in the study of contentious mobilization: economic theories of collective action and sociological theories of social movements. Study of dissident collective action in autocracies, democracies, and hybrid regimes (e.g. electoral autocracies). Explore contemporary movements including civil rights, ethnic and nationalist, religious, feminist, anti-abortion, peasant, and workers movements in Latin America, Western and Eastern Europe, North Africa, and the U.S. Draw on historical, quantitative and game-theoretic work. Instructor: Trejo. 3 units.

283S. Congressional Policy-Making (A). Lawmaking and oversight of the executive branch by the U.S. Congress. Committee, party, executive, and interest group roles. Instructor: Munger. 3 units.

286S. Theory and Practice of International Security (D). Analysis and criticism of the recent theoretical, empirical, statistical, and case study literature on international security. This course highlights and examines potentially promising areas of current and future research. No prerequisite, but Political Science 93 recommended. Instructor: Staff. 3 units.

289S. Contemporary Ethical Theories (C-N). 3 units. C-L: see Philosophy 203S


299. Advanced Topics in Government and Politics. Topics vary from semester to semester. A. American Government and Politics B. Comparative Government and Politics C. Political Theory D. International Relations Instructor: Staff. 3 units.

299AS. Advanced Topics in Government and Politics (American Politics). Advanced Topics in Government and Politics (American Politics). Same as Political Science 299A except in seminar format. Instructor: Staff. 3 units.

299BS. Advanced Topics in Government and Politics (Comparative Studies). Advanced Topics in Government and Politics (Comparative Politics). Same as Political Science 299B except in seminar format. Instructor: Staff. 3 units.

299CS. Advanced Topics in Government and Politics (Political Theory). Advanced Topics in Government and Politics (Political Theory). Same as Political Science 299C except in seminar format. Instructor: Staff. 3 units.

299DS. Advanced Topics in Government and Politics (International Relations). Advanced Topics in Government and Politics (International Relations). Same as Political Science 299D except in seminar format. Instructor: Staff. 3 units.

299S. Advanced Topics in Government and Politics. Same as Political Science 299 except in seminar format. Instructor: Staff. 3 units.

For Graduate Students Only

302. Advanced Quantitative Research Methods in Political Science. Theory and practice of likelihood inference for social science models, spanning binary, nominal, ordinal, count, and continuous random variables. Estimation, interpretation, and presentation of results will also be emphasized. Content may vary by year. Instructor: Staff. 3 units.

304. Classics in American Politics (A). Introduction to fundamental research and theoretic statements in American politics. Instructor: Aldrich, or Paletz. 3 units.

306. Public Opinion (A). Intensive study of the causes and consequences of public attitudes toward politics, with special attention given to recent research in the field. Instructor: Staff. 3 units.

307. Formal Modeling in Political Science (C-E). Introduction to formal analysis of recent work in political science. Focus on a number of important theorems and their proofs drawn from such areas as bargaining, deterrence, public goods, collective choice, electoral politics, and new institutionalism. Students will in the process be expected to begin work on formal proofs of their own. Prerequisite: one course in game theory. Instructor: Niou. 3 units.

308. Individual Research (A,B,C,D). Students will conduct research designed to evaluate hypotheses of their choice. Reports on the research must be presented in appropriate professional style. Instructor consent required. Instructor: Staff. 3 units.

309. Seminar in International Relations (D). Critical survey of theories and research in international relations and foreign policy. Emphasis will be placed on the interrelation between theory and research. Instructor: Staff. 3 units.


317. The New Institutionalism in Political Science (C-E). Survey of recent developments in information economics, theory of the firm, the property rights paradigm, and contract theory. Emphasis on using these techniques to answer classic questions in political science. Instructor: McKean. 3 units.

318. Introduction to Empirical Approaches to Political Science (M). Offers an introduction to empirical methods used in contemporary research in political science. Course develops an applied understanding of the linear regression model in the
context of political science research questions. Students will be able to evaluate and interpret allied aggression results as well as develop their own simple models. Required of all incoming graduate students. Instructor: Staff. 3 units.


320. Political Psychology (A). Examination of the human political situation through the study of actual problems and solutions at the level of: (1) the individual, (2) political discourse among government officials, (3) public discourse in the media. Instructor: Staff. 3 units. C-L: Psychology 317

321. Seminar in Political Theory (C-N). Prerequisite: 6 units in political science elected from 223, 224, 229, 231, or their equivalents. Instructor: Staff. 3 units.

325. Seminar in Comparative Politics (B). A field survey with emphasis on the politics of developing areas and politics of advanced industrial democracies. Instructor: Staff. 3 units.

326. Research Seminar in Comparative Government and Politics (B). Seminar in major issues in comparative politics and intensive individual student research projects. Instructor: Staff. 3 units.

327. Comparative Political Behavior (B). This seminar critically examines research on variations in elite and mass behavior as well as the conditions affecting that behavior in a variety of Western countries. Instructor: Staff. 3 units.

330. Research Design and Qualitative Methods. Systematic exploration of key issues in research design and methods: Examines epistemology, observation and description, causality, case selection, and case study research design. Also covers specific tools, methods, and special topics such as survey design and sampling, qualitative interviews, historiography and archival research, content analysis, experiments, field research, temporality and institutional change. Instructor: Büthe. 3 units.

332. Seminar on Political Economy: Micro Level (C-E). Survey of recent work in political science and economics on the organization of institutions: political, sociological, and economic. Focus upon the ways in which rational choice theory is applied to areas outside of economics. Instructor: Staff. 3 units.

333. Seminar on Political Economy: Macro Level (C-E). Survey and analysis of recent work in political science, economics, and sociology on the relationships between states and markets. Special emphasis on the ways states influence market outcomes and the ways the organization of power in markets influences state behavior, especially in democratic systems. Instructor: Lange or Soskice. 3 units. C-L: Sociology 333

345. Comparative Constitutional Design. Consideration of configurations of political institutions apt for democratizing countries, especially those divided by ethnic or religious affiliations. Begins with theories of constitutional and legal change and of efficacy of constitutions as instruments of conflict management, as well as alternative approaches. Specific issues include: electoral systems; federalism and regional devolution; the presidential-parliamentary debate; costs and benefits of judicial review; the special issue of Islam and the state. Extensive discussion of the overarching question of adoptability and emphasis on the relations between processes of constitutional change and the content of the institutions adopted. Instructor: Horowitz. 3 units. C-L: Law 717

351. Comparative Law and Politics: Ethnic Group Relations (B). Various approaches to the reduction of conflict in deeply divided societies, primarily in Asia and Africa, with secondary attention to Western countries. The nature of ethnic identity, the sources of group conflict, and the forms and patterns it takes. Methods of analyzing social science materials and utilizing them for the design of polities, laws, and institutions. Consent of instructor required. Instructor: Horowitz. 3 units.

370A. Workshop in Normative Political Theory and Political Philosophy. Research workshop in normative political theory and political philosophy. Instructor: Staff. 1 unit.

370B. Workshop in Normative Political Theory and Political Philosophy II. Research workshop in normative political theory and political philosophy. Students must complete POLSCI 370A before taking this course. Instructor: Staff. 1 unit.

371A. Workshop in Political Behavior and Identities. Research workshop in political behavior and identities. Instructor: Staff. 1 unit.

371B. Workshop in Political Behavior and Identities II. Research workshop in political behavior and identities. Students must complete POLSCI 371A before taking this course. Instructor: Staff. 1 unit.

372A. Workshop in Political Economy I. Research workshop in political economy. Content of the workshop continues in POLSCI 372B. Instructor: Staff. 1 unit.

372B. Workshop in Political Economy II. Research workshop in political economy. Students must complete POLSCI 372A before taking this course. Instructor: Staff. 1 unit.

373A. Workshop in Political Institutions I. Research workshop in political institutions. Content of the course continues in POLSCI 373B. Instructor: Staff. 1 unit.

373B. Workshop in Political Institutions II. Research workshop in political institutions. Students must complete POLSCI 373A before taking this course. Instructor: Staff. 1 unit.

374A. Workshop in Political Methodology I. Research workshop in political methodology. Content of the course continues in POLSCI 374B. Instructor: Staff. 1 unit.

374B. Workshop in Political Methodology II. Research workshop in political methodology. Students must complete POLSCI 374A before taking this course. Instructor: Staff. 1 unit.

375B. Workshop in Security, Peace, and Conflict II. Research workshop in security, peace and conflict. Students must complete POLSCI 375A before taking this course. Instructor: Staff. 1 unit.

390. Research Seminar in International Relations (D). Prerequisite: Political Science 226, Political Science 309 or equivalent. Instructor: Staff. 3 units.

395A. Research Seminar in Political Science I. Consideration of various elements involved in the conduct of research, including identifying topics for study, theory construction and application, gathering and marshaling evidence, and framing and presenting analysis. Ideas will be applied in collaborative research. Content of the course continues in Political Science 395B. Instructor: Rohde. 3 units.

395B. Research Seminar in Political Science II. Consideration of various elements involved in the conduct of research, including identifying topics for study, theory construction and application, gathering and marshaling evidence, and framing and presenting analysis. Ideas will be applied in collaborative research. Students must complete POLSCI 395A before taking this course. Consent of instructor required. Instructor: Rohde. 3 units.

397. Selected Topics in Government and Politics (A,B,C,D). Topics vary from semester to semester. Instructor: Staff. 2 units.


Psychology and Neuroscience

Professor Cooper, Chair; Associate Professor Bonner, Director of Graduate Studies; Professors Asher, Cabeza, Caspi, Cooper, Costanzo, Hariri, Hoyle, Leary, Meck, Moffitt, Putallaz, Roth, Rubin, Schmajuk, Sikkema, Strauman, Thompson, C. Williams, Whitfield, Wood; Associate Professors Bennett, Brannon, Day, Groh, Huettel, LaBar, Mazuka, Shah; Assistant Professors Bilbo, Egner, Feng, Harris, Joh, Linnenbrink-Garcia, Marsh, Mitroff, Wilbourn, Yin; Research Professor L. Wallach; Associate Research Professor Rabiner; Assistant Research Professor Richman; Lecturer Batson; Senior Lecturer Fellows Grimes, Murphy; Medical School Faculty: Blumenthal, Bonner, Curry (Director of Clinical Training), Keefe, Robins, Surwit, R. Williams; Professors Emeriti Coie, Eckerman, C. Erickson, R. Erickson, Hall, Kremen, Lockhead, M. Wallach; Faculty with Secondary Appointments: Professors Angold, Bettman, Brodie, Chartrand, Compton, J. Costello, Dodge, Edwards, Fairbanks, Fitzgerald, Fitzsimons, Flanagan, Fuemmeler, Gassman-Pines, George, Gibson-Davis, Gold, Gustafson, W. C. Hall, Hardy, Holditch-Davis, Larrick, Levin, Linville, Logue, Lynch, Madden, March, Nicolelis, Nowicki, Palmer, Payne, Platt, Purves, Rosenthal, Ruse, Schiffman, Sera, Sheppard, Sherwood, Siegler, Smith-Lovin, Spener, Stocking, Swartzwelder, Vidmar, Wells, Weinfurt, Welsh-Bohmer, Whidle, Zucker; Adjunct Professors Barbarin, Cox, McLoyd, Ornstein, Reznick, Vernon-Feagans; Adjunct Associate Professors Curran, Gariepy, Hopfinger, Hussong, Kurtz-Costes, and Taylor

Graduate training leading to a PhD in Psychology and Neuroscience is offered through a unique program that merges Social Sciences and Natural Sciences in the study of brain, behavior, and cognition in humans and animals. Program tracks are offered in Clinical Psychology, Cognition/Cognitive Neuroscience, Developmental Psychology, Social Psychology, and Systems and Integrative Neuroscience.

Psychology Courses (PSY)

201S. The Psychology of Mindfulness Meditation: Theory, Research, and Practice. Mindfulness meditation in relation to psychological and physical health. Traditional Buddhist teachings and contemporary Western perspectives on mindfulness. Survey of empirical research, including controlled trials and studies of basic mechanisms and processes through self-report, psychophysiological, and neuroimaging methods. Use of mindfulness practices in behavioral and other psychotherapies. Includes experiential learning through meditation practices in class and for homework assignments, as well as lecture and discussion. Readings mostly original journal articles and book chapters. Prerequisites: PSY 100R, 101RE, or 102RE desirable. Open to graduate and advanced undergraduate students. Instructor: Robins. 3 units.

202S. Autobiographical Memory (C). A review and critical analysis of the literature, theory, and empirical study of autobiographical memory within cognitive psychology. Emphasis on the reasoning, research designs, and methods used in examining autobiographical memory. Consent of the instructor required. Instructor: Rubin. 3 units.

203S. Genetics and Environment in Abnormal Behavior. Introduces students to an emerging topic in behavioral science: the interaction between genes and environments. Evaluates research showing that genes influence susceptibility to the environmental causes of abnormal behavior, and research showing that genes' connections to behaviors depend on environmental experiences. Readings are primary journal articles. Topics include the design and analysis of genetic research into mental disorders, and ethical issues stemming from genetic research into human behavior. Prior coursework in statistics/research methods, genetics, and/or abnormal psychology is desirable. Consent of instructor required. Instructors: Caspi and Moffitt. 3 units.

204S. Exploring the Prefrontal Cortex (B). Review and critical analysis of current and historical perspectives on functional neuroanatomy of the prefrontal cortex. Discussion is informed by anatomical, neuropsychological, neurological, neuroimag-
206S. Pediatric Psychology (D, P). The conceptual and methodological bases for the field. Emphasis on the reasoning, research designs, and methods implemented at the interface of behavioral and biomedical issues concerning health care for children. Case material illustrating how developmental, biological, and psychosocial processes act together in child health and illness. Focus on adjustment and coping with illness and treatments related to cystic fibrosis, sickle cell disease, cancer, diabetes, and seizure disorders. Consent of instructor required. Instructor: Bonner. 3 units.

207S. Developmental Behavior Genetics (D). Review estimates of the contribution of genetic and environmental variance to developmental concepts across the life span. Basic understanding of the statistical approach to behavioral genetics. Consent of instructor required. Instructor: Shah. 3 units.

208S. Gender, Pain, and Coping (P). Examination of recent research on gender differences manifested in severity of pain, in healthcare seeking behaviors for painful conditions, and in responses to pain management interventions such as medications or self-help efforts. Exploration of gender-related factors, psychological, social, spiritual, cultural, and biological, which influence responses to persistent pain. Writing intensive seminar requiring student critiques of recent journal articles focused on sex and gender differences in the pain experience, as well as a review paper analyzing recent research in this area. Instructor: Keefe. 3 units.

209S. Disturbances in Eating and Body Experience Across the Lifespan. Examination of the empirical literature with emphasis on the functions that peers serve for children, the developmental course of these relationships, the clinical ramifications and possible explanations for inadequate peer relations (including an examination of the family's role), and interventions used to improve children's relationships with their peers. Regular opportunities to analyze, critique, and synthesize primary research literature. Consent of instructor required. Instructor: Putterman or Putallaz. 3 units.

210AS. Multidisciplinary Approaches to Contemporary Children's Issues. 2 units. C-L: see Children in Contemporary Society 210S; also C-L: see Children in Contemporary Society 210S

211S. Biology of Nervous System Diseases. 3 units. C-L: see Biology 241S; also C-L: Neuroscience 242S

214S. Motivational Approaches to Social Psychology (P). Advanced topics in the reemerging focus in social psychology on motivation and its role in determining the nature and consequences of self and social-regulation. Focus on research and theorizing on differing motivations underlying social behavior (e.g., the motivations characterizing stereotyping and prejudice as well as achievement behavior and interpersonal relationships). Students expected to read research articles and chapters from the leading social psychology outlets and to actively discuss the merits and limitations of this theory and research. Consent of instructor required. Instructor: Shah. 3 units.


216S. Gender, Pain, and Coping (P). Examination of recent research on gender differences manifested in severity of pain, in healthcare seeking behaviors for painful conditions, and in responses to pain management interventions such as medications or self-help efforts. Exploration of gender-related factors, psychological, social, spiritual, cultural, and biological, which influence responses to persistent pain. Writing intensive seminar requiring student critiques of recent journal articles focused on sex and gender differences in the pain experience, as well as a review paper analyzing recent research in this area. Instructor: Keefe. 3 units.

218S. Personality, Stress, and Disease (P). The interaction between person and social environment as a contributor to development of physical disease. Both epidemiological and laboratory-based research considered. Prerequisite: Psychology 109A for undergraduates and consent of instructor. Instructor: R. B. Williams. 3 units.


226S. Cognitive Neuroscience of Memory (C). Research on the neural correlates of memory in humans. Neuropsychological studies with brain-damaged patients and functional neuroimaging studies with healthy individuals. Cognitive neuroscience models of memory, including episodic memory, working memory, semantic memory, priming, and procedural memory. Prerequisite: Psychology 101(RE), formerly 91, or Psychology 102(RE), formerly 92, and consent of instructor. Instructor: Cabeza. 3 units. C-L: Neuroscience 216S

227S. Behavioral Physiology: Basic Systems (P). Organ systems review of physiology, emphasizing the role of the central nervous system and behavior in physiological function. Emphasis on the research designs, methods, and reasoning by which
the physiology of behavior is understood. Prerequisite: Psychology 101(RE)-formerly 91 or 159S for undergraduates and consent of instructor. Instructor: Surwit. 3 units.

229S. Psychosocial Determinants of Health. Provides an in-depth understanding of psychosocial determinants of health. Emphasis on the ways psychological factors interact with social, cultural, economic, and environmental contexts of health. Topics include impact of social integration, socioeconomic position, discrimination, health behaviors, and affective states on health outcomes. Students will gain competency through lectures, discussions, written work, and oral presentations. Prerequisite: Psychology 99 or 116, Research Methods. Open to Juniors, Seniors and Graduate students. Instructor: Staff. 3 units.

230S. Stereotypes and Stigma (P). Experimental research in stereotyping and stigma; readings from psychology, public health, and sociological perspectives on issues related to ethnicity, gender, and social class. Consent of instructor required. Prerequisites: Psychology 99 and 104(RE)-formerly 116. Instructor: Richman. 3 units.

238S. Everyday Cognition (C). Selected cognitive processes (e.g., encoding, retrieval, representation, information load) and how they work in everyday settings. Cognition in classrooms, courtrooms, hospitals, grocery stores, jobs, athletics, and dance. Special focus on medical cognition, courtroom cognition, and memory for movement. For each setting, successful vs. mediocre performance, task analysis, errors, experiments, applications. Presentations by the instructor, students, and specialists from the everyday world (e.g., pharmacists, judges, choreographers). Instructor consent required. Instructor: Day. 3 units.

240S. Biological Pathways to Psychopathology (A,P,B,C). Introduces students to emerging methodologies for understanding the biological pathways of psychopathology. Evaluates research showing that the integration of psychology, neuroimaging, pharmacology and genetics can illuminate specific biological pathways that help shape risk for and emergence of psychopathology. Readings are primary journal articles. Topics include the design and analysis of multimodal research (fMRI, PET, pharmacology, molecular genetics) examining the biological underpinnings of behavioral traits relevant to psychopathology. Prior coursework in biological psychology, i.e., PSY 101RE (formerly PSY 91) or its equivalent is recommended. Instructor consent required. Instructor: Hariri. 3 units.

241S. Affective Neuroscience (B, C). A critical examination of current theory and experimental research related to neurobiology of emotional information processing and emotion-cognition interactions. Topics range from animal studies to clinical disorders, including neurogenomics, social cognition, functional brain imaging, emotional learning and memory, neuroethics, and individual differences. Basic background in neuroanatomy and cognitive neuroscience expected. Consent of instructor required. Prerequisites: Psychology 135 or Psychology 112. Instructor: LaBar. 3 units. C-L: Neuroscience 211S

242S. Nonverbal Cognition. Exploration of Nonverbal cognition in animals and human infants. Focus on nonverbal counting and the relationship between the representation of number, time, and space. Topics include animal cognition, developmental psychology, neuropsychology, and brain imaging to sketch a complete picture of how the mind represents number in the absence of linguistic counting. Upper level undergraduates may enroll with consent of the instructor. Prerequisite: Consent of instructor. Brannon. 3 units.

249S. Anthropology and Psychology (C, P). 3 units. C-L: see Cultural Anthropology 249S

250S. Hormones, Brain, and Cognition (B, C). Current research on how hormones modify and modulate cognitive processes across the lifespan. Consent of instructor required. One course. Instructor: C. Williams. 3 units. C-L: Neuroscience 250S

258S. Social Behavior and Personality (P). Broad examination of current theory and research on the interpersonal, personological, and social cognitive influences on social interaction/behavior. Emphasis on: nature of social influence, function/construction of the self, relationship formation/maintenance, aggression, altruism, personality-based mediators and moderators of social behavior, and application of social psychological theory/research to real-world issues. Methodologies discussed = experimental, quasi-experimental, narrative, observational, and correlational models. Prerequisite: Psychology 99 or 104(RE)-formerly 116 and 185B and Statistics 101, Psychology 117 or equivalent and consent of instructor for undergraduates. Instructor: Costanzo or Hoyle. 3 units.

262S. Minority Mental Health: Issues in Theory, Treatment, and Research (P). Survey and discussion of theoretical, research, and clinical issues in minority mental health with special emphasis on African-Americans. Prerequisite: Psychology 100(RE)-formerly 119A for undergraduates and consent of instructor. Instructor: Staff. 3 units. C-L: African and African American Studies 262S

265. The Biological Basis of Music. 3 units. C-L: see Neurobiology 259; also C-L: Philosophy 259, Music 259

267S. Language, Brain, and Human Behavior. 3 units. C-L: see Linguistics 202S; also C-L: English 204S

268. Brain and Language (B, C). 3 units. C-L: see Linguistics 268; also C-L: Neuroscience 268

270PS. Selected Problems: Self and Social Behavior. Overview of psychological theory and research involving the role of self-attention in human thought, emotion, motivation, and behavior; open only to seniors and graduate students. Instructor: Leary. 3 units.

270S. Special Topics in Psychology. Topics vary by semester and section from the different areas of Psychology: Biological, Cognitive, Developmental or Personality/Social. Consent of instructor and/or specific prerequisites may be required for specific offerings. Open to Undergraduate as well as Graduate/Professional students. Instructor: Staff. 3 units.

272S. Obesity and Eating Disorders (B, P). A review of obesity and of the major clinical eating disorders (including binge
coping skills training. Key clinical trials in four health areas—cardiovascular disease, cancer, metabolic disorders, and pain will
be reviewed. Students will be expected to prepare an oral presentation on a research topic of their choice, and submit a written research proposal at the end of the semester. Prerequisites: Psychological Assessment; Psychotherapy. Consent of instructor required. Instructor: Staff. 3 units.

290. Special Topics in Psychology. Advanced topics vary by semester and section from the areas of Psychology: Abnormal/ Health, Biological, Cognitive, Developmental or Social. Consent of instructor and/or specific prerequisites may be required for specific offerings. Open to Undergraduate and Graduate/Professional students. Instructor: Staff. 3 units.

For Graduate Students Only

305. Adult Psychopathology. Examination of current diagnostic and theoretical approaches to adult psychopathology and personality disorders and the implications of diagnostic and theoretical systems for assessment and treatment. Instructor: Strauman. 3 units.

306. Interventions in Behavioral Medicine and Health Psychology. Review critical elements of randomized clinical trials in behavioral medicine and clinical health psychology. Discuss basic issues of study design including identification of target population, selection of outcome measures, blinding, use of control groups, randomization, power analyses, and data analytic approaches. Examine a variety of behavioral interventions including stress management, diet, exercise, pain management, and coping skills training. Key clinical trials in four health areas—cardiovascular disease, cancer, metabolic disorders, and pain will be reviewed. Students will be expected to prepare an oral presentation on a research topic of their choice, and submit a written research proposal at the end of the semester. Prerequisites: Psychological Assessment; Psychotherapy. Consent of instructor required. Instructor: Staff. 3 units.

307. Models of Intervention and Prevention. Review of empirically-supported treatments for adult disorders. Therapeutic relationship issues and communication style; strategies commonly used across disorders in empirically-supported treatment and prevention programs; their application to specific disorders; development of theoretically integrative treatments. Course balances discussion of theory and research findings with practical and ethical issues in treatment delivery, illustrated by case transcripts and videotapes. Instructor: Robins. 3 units.

310. Diversity and Mental Health: Issues in Theory, Treatment and Research. Discussions of theoretical, research, and clinical issues in multicultural psychology. Increase multicultural awareness and skills to conduct research and clinical practice. Consent of instructor required. Instructor: Staff. 3 units.

312. Development of Achievement Motivation. Analysis of the development of achievement motivation from multiple theoretical perspectives; consideration of contextual influences on achievement motivation, with a specific emphasis on home and school factors; discussion of empirical evidence regarding the role of achievement motivation in engagement and learning in school. Implications for educational practices and policies will be discussed. Instructor: Linnenbrink-Garcia. 3 units.

313. Motivation Science in Social Psychology. This graduate level course will explore the reemerging focus in social psychology on motivation and its role in determining the nature and consequences of self and social-regulation. Specifically, this seminar will focus on research and theorizing on the differing motivations underlying social behavior (such as the motivations characterizing stereotyping and prejudice as well as achievement behavior and interpersonal relationships). Students will be expected to read research articles and chapters from the leading social psychology outlets to actively discuss the merits and limitations of these research traditions. Students will also be expected to actively participate in weekly discussions and to present a grant proposal for a research study inspired by the weekly reading assignments and classroom discussion. Because this is an advanced graduate seminar, registration requires instructor approval. Instructor: Staff. 3 units.

315. Seminar in Consumer Behavior. 3 units. C-L: see Business Administration 562

316. Behavioral Decision Theory. 3 units. C-L: see Business Administration 525; also C-L: Statistical Science 231

317. Political Psychology (A). Examination of the human political situation through the study of actual problems and solutions at the level of: (1) the individual, (2) political discourse among government officials, (3) public discourse in the media. Instructor: Staff. 3 units. C-L: Political Science 320

318. Research Design. Methodology principles of research design in psychology. Experimental, quasi-experimental and correlational research. Permission of instructor required. Instructor: Cooper. 3 units.

320. Applied Multivariate Statistics. Applications of multivariate statistics in psychology and related disciplines. Topics include: MANOVA, factor analysis, principal components analysis, cluster analysis, multidimensional scaling, multiple logistic regression, and various approaches to longitudinal data analysis. Covers issues in applied data analysis such as a priori and post-hoc power analyses, transformation of data, and graphical/written/oral presentation of results. Data analyzed using the SAS statistical software package, as well as other specialty programs. Mandatory weekly lab sessions. Prerequisite: Psychology 273 and 274 or equivalent. Consent of instructor required. Instructor: Staff. 3 units.

321. Social Development. Analysis of children's social development from multiple theoretical perspectives including biological, social cognitive, social learning, and ecological perspectives. Includes socialization in the contexts of families, peers, schools, and neighborhoods and the role of media. Implications for prevention/intervention programs and social policy are discussed. Permission of the instructor required. Instructor: Ascher. 3 units.

322. Advanced Cognitive Development. Advanced level introduction to critical issues in the study of cognitive development from birth to adolescence. Emphasis on both theoretical accounts of cognitive development and recent research that informs these explanations. Permission only. Instructor: Staff. 3 units.
327. Theories of Developmental Psychology. Examine worldviews and assumptions that underlie theories in developmental psychology; discuss the philosophical and historical foundations for key ideas and theories in the study and understanding of human development, take on the perspectives of key historical figures in developmental psychology; understand how change and development have been conceptualized over the history of the field; debate ongoing controversies in the field such as nature-nurture, continuity-discontinuity, universal-culturally specific development; explore the link among theoretical perspectives, research methodologies and data interpretation. Permission of instructor required. Instructor: Staff. 3 units.

329S. Foundations of Cognitive Development. Introduction to main theories and concepts of cognitive development as it is studied from psychological and neuroscience perspectives. Instructors: Brannon or Needham. 3 units.

330S. Foundations of Cognitive Psychology. Current concepts and controversies in the way people and other animals perceive, think, and remember. Instructor: Staff. 3 units.

332. Developmental Psychopathology. This course examines major emotional and behavioral disorders of childhood/adolescence from a developmental perspective. Issues addressed include risk and protective factors, long-term outcomes, and prevention/intervention. Instructor: Rabiner. 3 units.

333. Cognition and Teaching. An examination of key phenomena and concepts in cognitive psychology (especially in areas of perception, attention, memory, comprehension, mental representation, and problem solving) and their implications for the teaching-learning process at the college level. Instructor: Day. 3 units.

335. Personality Assessment. A course for clinical graduate students on assessment of persons through a variety of methods, including personological, clinical and semi-structured interviews, analysis of narrative material, and psychological tests. Introduction to self-report, observer-report, and projective methods. Consent of instructor. Instructor: Curry. 3 units.

339. Ethical Issues in Research and Clinical Practice. Topics including ethical issues in teaching, research, and clinical practice. Instructor: Staff. 3 units.

343. Clinical Practicum. Intensive experience and supervision in clinical intervention processes. Student training in psychotherapy strategies and techniques and in clinical consultation skills is conducted in clinical settings. 0 to 6 units. Instructor: Staff. Variable credit.

344. Clinical Practicum. Intensive experience and supervision in clinical intervention processes. Student training in psychotherapy strategies and techniques and in clinical consultation skills is conducted in clinical settings. 0 to 6 units. Instructor: Staff. Variable credit.

345. Teaching Practicum. Experience based on teaching assistantship for fall semester. Instructor: Bonner. 3 units.

346. Teaching Practicum. Experience based on teaching assistantship for spring semester. Instructor: Bonner. 3 units.

348. Child/Adolescent Psychotherapy. Introduction to psychodynamic and cognitive-behavioral approaches to clinical problems of children and adolescents, with an emphasis on empirically-supported interventions. Instructor: Curry. 3 units.

349. Practicum in Psychological Research. Instructor: Staff. 3 units.

350. Practicum in Psychological Research. Instructor: Staff. 3 units.

352. Child Assessment. Interview methods; intelligence and achievement testing; personality and developmental batteries; peer, teacher, and parental instruments; and observational techniques. Instructor: Fitzgerald and Whidby. 3 units.

354. Clinical Assessment. This course enables students to master a key professional skill of the clinical psychologist that is used in internship, clinical practice, and academic research. Theory topics include psychometric measurement, the science of test construction, the politics and history of mental testing, and the misuses of mental testing. Students learn to evaluate and critique tests. Students learn to administer, score and interpret WPPSI, WISC, WAIS, and selected tests of academic achievement and neuropsychological brain functions. Students learn to write a formal report of assessment findings, to give oral consultations to patients, parents and referring physicians, to understand the legal aspects of assessment practice, and to appropriately apply test for diagnosis and treatment planning. Instructor: Moffitt. 3 units.

355. Research Practicum. Students will be involved in a research apprenticeship to a faculty member for hands-on experience with research efforts. Instructor: Staff. 3 units.

356. Research Practicum. Students will be involved in a research apprenticeship to a faculty member for hands-on experience with research efforts. Instructor: Staff. 3 units.

357S. Cognitive Neuroscience Colloquia. Graduate students (2nd year and higher) and other research trainees (e.g. postdocs) in cognitive neuroscience will each take a turn at presenting a research topic (e.g. a research update, a practice talk, an experimental proposal, presentation of a scientific article) in a forum aimed at helping junior researchers develop and hone their presentation skills. Consent of instructor required. Instructor: Woldorff and staff. 1 unit.

359S. Principles in Cognitive Neuroscience I. Introduction to the cognitive neuroscience of emotion, social cognition, executive function, development, and consciousness. Topics also include cognitive disorders, and computer modeling. Highlights current theories, methodological advances, and controversies. Students evaluate and synthesize findings across a variety of research techniques. Consent of instructor required. Instructor: Cabeza, Labar, Purves, or Woldorff. 3 units. C-L: Neurobiology 349S, Philosophy 359S

360S. Principles in Cognitive Neuroscience II. Introduction to the cognitive neuroscience of emotion, social cognition, executive function, development, and consciousness. Topics also include cognitive disorders, and computer modeling.
Highlights current theories, methodological advances, and controversies. Students evaluate and synthesize findings across a variety of research techniques. Consent of instructor required. Instructor: Cabeza, Labar, Purves, or Woldorff. 3 units. C-L: Neurobiology 350S, Philosophy 360S

362. Functional Magnetic Resonance Imaging. The course covers all aspects of functional magnetic resonance imaging, from its basic principles in physics, engineering, biophysics, and physiology; through computational, analytic, and signal processing issues; to its applications in neurobiology and cognitive neuroscience. The course will consist of weekly lectures and integrated laboratory sessions. Lectures will be given by BIAC faculty, and will incorporate primary readings in the field to encourage discussion. The laboratory sessions will involve analysis of fMRI data sets that illustrate issues discussed in the lectures. Students will gain experience both in the theoretical principles of fMRI and in the practical aspects of experimental design and data analysis. Instructor: Huettel. 3 units. C-L: Neurobiology 381

363S. Psychology and Neuroscience First Year Seminar I. Analysis and discussion of current models and research in psychology and neuroscience. Focus is on theories and research in brain-behavior relations, particularly those relevant for perception, memory, and attention in humans and animals. Instructor: Staff. 1.5 units.

364S. Psychology and Neuroscience First Year Seminar II. Analysis and discussion of current models and research in psychology and neuroscience. Focus is on theories and research in brain-behavior relations, particularly those relevant for perception, memory, and attention in humans and animals. Instructor: Staff. 1.5 units.

366. Applied Analysis of Variance. Application of analysis of variance typical in psychology and related disciplines. Introduction to the general linear model. Foundations of experimental design, probability, inference. Topics include: one factor ANOVA, factorial ANOVA with two- and three-way interactions, trend analysis, within-subjects designs, analysis of covariance, effect size and power estimation. Equips students to apply, interpret, and report results of ANOVA. Training in the use of SAS statistical computing system. Mandatory weekly lab sessions. Assumes undergraduate statistics course; understanding of basic statistical concepts. Consent of instructor required. Instructor: Staff. 3 units.

367. Applied Correlation and Regression Analysis. Applications of correlation and regression analysis typical in psychology and related disciplines. Correlation topics include: computing, testing, and comparing zero-order, partial, and semi-partial correlation coefficients. Regression topics include: logic of model comparison, hierarchical analysis, effect and dummy coding, interaction effects, curvilinear effects, diagnostics, and power estimation. Equips students to apply, interpret, and report results of correlation and multiple regression analyses. Training in the use of the SAS statistical computing system. Mandatory weekly lab sessions. Assumes prior graduate training in general linear model. Consent of instructor required. Instructor: Staff. 3 units.

368. Applied Structural Equation Modeling. Applications of structural equation modeling typical in psychology and related disciplines. Topics include: notation, path diagrams, specification and identification, estimation, modification, power estimation, measurement models, multivariate regression models, panel models, growth models. Emphasis on model comparisons, limits on causal inference. Equips students to apply, interpret, and report results of structural equation modeling analyses. Training in the use of relevant software. Mandatory weekly lab sessions. Prerequisite: Psychology 274 or equivalent. Consent of instructor required. Instructor: Staff. 3 units.

369. Research Synthesis and Meta-Analysis (G). 3 units. C-L: see Education 369

370. Applied Multilevel Modeling. Applications of multilevel modeling typical in psychology and related disciplines. Estimation and interpretation of models for multilevel data structures, including data generated by clustered and longitudinal designs. Examination of conceptual, substantive, and methodological issues in analyzing multilevel data. Focus on appropriately conceptualizing, modeling, and reporting research on multilevel data. Training in the use of relevant statistical software. Mandatory weekly lab sessions. Assumes prior graduate training in applications of analysis of variance and multiple regression. Consent of instructor required. Instructor: Staff. 3 units.

380S. Foundations of Behavioral and Computational Neuroscience. Survey and in depth discussion of the methods, theory, and current research in the field of behavioral and computational neuroscience. Emphasis on animal models and neurobiological underpinnings of learning, memory, and cognition. Covers the latest developments in research on neuroanatomical, cellular and molecular substrates of behavior with emphasis on the influence of development, environment, and experience across the lifespan. Instructor: Buhusi, Williams, Staff. 3 units.

381. Data Methods in Cognitive Psychology. Introduction to the analysis of behavioral data from cognitive research with a focus on the separation of accuracy and response strategy. Particular emphasis on Signal Detection Theory and other basic statistical decision models. Application of Matlab to both basic Monte Carlo simulation and cognitive experiment generation. Simple estimation of the parameters of decision models using iterative search algorithms and the use of bootstrap techniques to estimate the variability of parameter estimates. Investigation of the basic relationship between decision models and statistical tests typically used behavioral data analysis such as Student's t-test. Instructor: Staff. 3 units.

391. Special Topics in Psychology. This seminar is designed to provide students with an opportunity to engage in an advanced and intensive examination of the research literature on a special topic in psychology. Specific topics will vary by semester. Instructor: Staff. 3 units.

392. Special Topics in Psychology. This seminar is designed to provide students with an opportunity to engage in an advanced and intensive examination of the research literature on a special topic in psychology. Specific topics will vary by semester.
Public Policy

Professor B. Kuniholm, Chair (124 Sanford Institute); Professor J. Vigdor, Director of Graduate Studies (252 Rubenstein Hall); Professors Bradley (law), Chafe (history), Clotfelter, Cook, Darity, Dodge, Feaver (Political Science), Fleishman (law), Frankeneng, Hamilton, James, Jenleson, Korstad, B. Kuniholm, Ladd, McClain (political science), Mickiewicz, Munger (political science), Nechyba (economics), Price (political science), Sanders, Schroeder (law), Sloan (economics), T. Taylor (sociology), Whitman (sociology). Associate Professors Bennear (environment), Brady (political science), Nechyba (economics), Price (political science), Sanders, Schroeder (law), Sloan (economics), T. Taylor (sociology), Whitman (sociology), Charles (hospitality). Assistant Professors of the Practice Charney, Fernholz, Hopp (polisci), Krupp, and Schanzer; Adjunct Professors Yaggy and Rosch; Lecturers Blount (economics), J. Vigdor, Vincent (environment), and Weiner (law); Associate Professors Bennear (environment), Brady (sociology), Conrad, Kelley, Korstad, Krishna, Mayer, Merli, Pattanayak, Peck, Pfaff, D. Taylor, Wheeler; Assistant Directors of Graduate Studies Ananat, Bellemare, Bermeo, Gassman-Pines, Gibson-Davis, Goss, Hamoudi; Research Professors Cook-Deegan and Vaupel; Associate Research Professor Pickus; Assistant Research Professor Muschkin; Professors of the Practice Bennett, Brown, Cohen, Glenday, Harris, Johnson, Joseph, Kelly, Lethem, Shukla, Skloot, So, and T. Taylor. Associate Professors of the Practice Charnley, Fernholz, Krupp, and Schanzer; Adjunct Professors Yaggy and Rosch; Lecturers Blount and Rogers; Research Scholar E. Vigdor; Visiting Associate Professor of the Practice Schanzer; Visiting Research Scholars Martin-Staple and Mirovitskaya; Visiting Lecturer D. Kuniholm

The PhD in Public Policy is an applied, interdisciplinary social science degree. Graduates of the program are prepared for academic positions in public policy, public administration, and other policy-oriented schools, and for professional positions in domestic and international public agencies, research organizations, and policy consulting firms.

The program requires a two-course sequence in theories of public policy, microeconomics, and research methods. Students also complete coursework in a designated disciplinary concentration such as economics, political science, or sociology, as well as a policy focus, such as social policy, globalization and development, or health policy. Students in the program are expected to pass a comprehensive exam at the beginning of the third year and a preliminary exam that is a dissertation prospectus at the end of the third year.

Students who complete sufficient coursework and either the comprehensive exam or a substituted completion exercise may be eligible for the MA in Public Policy.

More information about the PhD Program in Public Policy and the MA in Public Policy can be found at http://www.sanford.duke.edu/.

Public Policy Studies Courses (PUBPOL)

PO 201S. Poverty, Inequality, and Public Policy in The U.S. Examines causes and consequences of poverty and inequality in the United States; reviews major social policies used to combat poverty's ill effects. Acquaint students with definition and extent of poverty and inequality, examine poverty's "causes", including family structure and low wage employment, discuss effects of poverty on family and child well-being, and analyze the primary poverty policies employed by the United States, including Temporary Aid to Needy Families, Food Stamps, Medicaid, and WIC. Lecture and class discussion, drawing on material from a variety of disciplines. Instructor: Gibson-Davis. 3 units.

PO 203S. Understanding Ethical Crisis in Organizations. 3 units. C-L: see Study of Ethics 202S; also C-L: Political Science 225S, Sociology 202S

PO 204. International Trade and Policy. Focus on economics of trade and trade policy. Includes theoretical models explaining patterns of trade, economic gains from trade, and distribution effects (winner and losers), as well as the economic effects of trade barriers, major agencies and institutions affecting trade, preferential trading arrangements, outsourcing and offshoring, multinationals, and labor and environmental issues. (No finance.) Instructor: Krupp. 3 units. C-L: Economics 253

PO 206S. Assisting Development. Examines evolution of international development theory and practice since early 1950s. Investigates how different solutions advanced to deal with poverty have fared. Different streams of academic and policy literature, including economics, political science, and sociology, are consulted with a view to understanding what could have been done in the past and what should be done at the present time. Examines alternative formulations weekly in seminar format. Individual research papers (60% of grade) which analyze past and present development practices in a country of their choice, or examine trends within a particular sector (e.g., agriculture, population, gender relations, the environment). Instructor: Krishna. 3 units. C-L: Political Science 227S

PO 207S. Poverty Policy After Welfare Reform. Will examine evidence on the effects of the 1996 welfare reform and study the piecemeal anti-poverty programs that have risen in place of traditional welfare. Will discuss how future poverty policies might address concerns that have risen in prominence since welfare reform, such as men as a neglected constituency and the challenges for low-income workers posed by technology and globalization. Familiarity with microeconomic principles will be helpful. Instructor: Ananat. 3 units.

PO 208S. Philanthropy: the Theory of Practice and the Practice of Theory. Role of grantmaking foundations as engines of
social, economic, and political change. Normative implications for democracy of elites using wealth to influence society. Theories of strategic vs. expressive philanthropy. Debate over time-limited vs. perpetual foundations. Cases of philanthropy's impact in realms such as education, public television, and AIDS research. New philanthropic ventures that hybridize for-profit and non-profit approaches. Consulting project to guide newly wealthy individuals in philanthropic strategy. Instructor: Goss. 3 units.

211S. Gender, Identity, and Public Policy. The role of women and women's organizations as advocates for, and targets of, public policymaking. The grounding of women's collective action claims in understandings of women's "sameness as" and "difference from" men, and the implications of those frames for women's citizenship. Gender differences in individual civic engagement and in the styles and priorities of male and female elected officials. The historic evolution of women's organizational engagement in gender-specific and general-purpose public policies. The impact of globalization on women. The oppression and emancipation of women in traditional societies. The legitimacy crises facing maternal, second wave, and third wave feminism. Instructor: Goss. 3 units. C-L: Political Science 216S, Women's Studies 211S

212S. Economics of the Family. Examines ways extended families function as economic institution. Primarily empirical, but also draws on relevant microeconomic theory. No formal prerequisites, but students should have experience with intermediate microeconomics and econometrics/statistics. Instructor: Hamoudi. 3 units.

213S. Designing Innovation for Global Health: From Philanthropy to People. The policy and philanthropic landscape behind appropriate technologies for global health. Focus is on developing countries and problems specific to those settings. Topics examined include: policies to minimize inequity, appropriate level of intervention for an innovation (individual, group, community), intellectual and financial capital, end-user input, systems for sharing and owning knowledge, philanthropy, ethical issues, and policy ramifications. Several weeks devoted to examination of specific technologies and problems, including access to medicines, malnutrition, clean water, and information technology. Instructor: So. 3 units.

216S. Race, Ethnicity and Social Policy. Explores in depth policies of redress for intergroup disparities or inequality across countries. Examination of policies that attempt to systematically correct differences across racial/ethnic groups in income, wealth, health, rates of incarceration, political participation, and educational attainment, e.g. affirmative action, land redistribution, parental school choice, and income redistribution measures in a number of countries including India, the United States, Brazil, Malaysia, Chile, and South Africa. Address question of why intergroup differences in outcomes should be viewed as a social problem. Instructor: Darity. 3 units. C-L: Public Policy Studies 216S

217S. Schoolling and Social Stratification. This course will examine educational policies in a comparative, cross-national fashion with a focus on the implications for the construction of social hierarchy and inequality. Instructor: Darity. 3 units. C-L: African and African American Studies 217S, Education 217S

218. Macroeconomic Policy and International Finance. Survey of macroeconomic theory and analysis of policies designed to reduce unemployment, stimulate economic growth, and stabilize prices. Conventional monetary and fiscal instruments, employment policies, and new policies designed to combat inflation. Instructor: Staff. 3 units. C-L: Economics 218

219S. American Grand Strategy. 3 units. C-L: see Political Science 219S; also C-L: History 220S

220. Using Data to Analyze and Evaluate Public Policy. This course reviews the basic methods of inferring the causal impact of public policy initiatives. Topics include randomized controlled trials, instrumental variable analysis, regression discontinuity designs, difference-in-difference "natural experiments," and propensity score/nearest neighbor matching methods. Assignments include analysis using Stata software; final project entails proposing a quantitative study focused on causal inference. Either Statistics 101 or Public Policy 312 required; further coursework in multiple regression preferred. Consent of instructor required. Instructor: Ananat or J. Vigdor. 3 units.

221. Media and Democracy. Examines the relationship between mass media and democracy in the United States, other developed democracies, and societies in transition. Seeks to explain how the media cover politics and public policy, examining the nature of media institutions, the economics of news production and consumption, and the strategic interplay of politicians, journalists, editors, and other actors who influence the content of news. Instructor: Mickiewicz. 3 units. C-L: Visual Studies 251A

222S. Advanced Magazine Journalism. Advanced version of PPS 119S. Students study current magazines as cultural documents; read and analyze stories across a broad swath of magazines; research, report, and write stories on complex public policy issues; conceptualize a magazine as a class project. Instructor: Bliwise. 3 units.

223S. Collective Action, Environment & Development. Examines the conditions under which collective or participatory decisions may raise welfare in defined ways. Presents the growing empirical evidence for an environment and development setting including common property issues (tragedy of the commons and competing models). Identifies what evidence exists for sharing norms on a background of self-interested strategies. Definitions of and reactions to equity and/or its absence are a focus. Providing scientific information for policy is another. Experimental and behavioral economics are frequently applied. Instructor: Pfaff. 3 units. C-L: Environment 244S

224. Population, Health and Policy. Substantive findings and policies/policy debates around selected topics in the field of population and health in industrialized and developing societies. Demographic models used to examine selected current population and health topics through framing, defining and evaluating key concepts. Topics include: end of population growth; relations between population, development and environment; health of populations; population aging; potentials for mortality
increases; HIV/AIDS epidemic and resurgence of infectious diseases. Readings from disciplines of demography, sociology and public health. Topics Course. Instructor: Merli. 3 units. C-L: Sociology 234

225S. Monuments and Memory: Public Policy and Remembrance of Racial Histories. Processes of memorialization of various dimensions of racial pasts, via statuaries, naming of parks and buildings, films (both documentary and fiction), novels, historical works. In depth treatment of political and economic basis for determining what events or persons are remembered and how they are remembered. Interdisciplinary course encompassing literary studies, memory studies, history, political science, anthropology, and economics. Instructor: Darity. 3 units. C-L: African and African American Studies 225S

226S. Urban Policy. Overview of basic political, sociological, and economic models of urbanization coupled with application of these models to modern urban problems, including concentrated poverty, traffic congestion and mass transit, crime, land use and environmental quality, housing affordability, and fiscal crises. Special emphasis on historical evolution of cities. Students write a major project focusing on the problems facing one American city, and propose solutions to those problems. Instructor: Staff. 3 units.

227. Economic Evaluation of Sustainable Development. Examines how one could rationally defend a choice of "sustainable development" policy. Applies cost-benefit thinking in environment-natural-resources and development contexts. Presents microeconomic concepts emphasizing logic and principles more than mechanics. Intertemporal equity is a focus and equity-efficiency tradeoffs are a theme. Microeconomics prerequisite not required. Instructor: Pfaff. 3 units. C-L: Environment 227

228S. International Democratization. Focus on critical analysis of international efforts to improve governance, build democracy and increase respect for human rights through a series of methods or tools: international law, sanctions, aid, conditionality, and a vast array of activities broadly labeled democracy promotion, including election assistance and civil society development. Class requires a high level of discussion and preparation for each meeting. Emphasis on student application of reading material to a particular country. Instructor: Kelley. 3 units. C-L: Political Science 228S

229S. Poverty, Inequality, and Health. Impact of poverty and socioeconomic inequality on the health of individuals and populations. Attention given to both United States and non-United States populations. Topics include the conceptualization and measurement of poverty and socioeconomic inequality; socioeconomic gradients in health; globalization and health; socioeconomic deprivation across the life course and health in adulthood; and public policy responses in the United States and elsewhere to growing health inequities in the age of globalization. Prerequisite: An introductory course in statistics. Seniors and graduate students only. Instructor: James. 3 units. C-L: African and African American Studies 229S

231S. Law, Economics, and Organizations. Overview of field of law and economics. Economics of information, contract theory, economic analysis of law, and New Institutional Economics. Consequences of failure of law and institutions; alternative mechanisms to sustain markets and transactions. PPS 128 prerequisite or instructor approval. Instructor: Bellemare. 3 units. C-L: Economics 231S

232S. Microeconomics of International Development Policy. Microeconomic foundations of international development policy using tools of microeconomics to study behavior of individuals, households, and firms in developing countries. Topics may include household and intrahousehold modeling; market participation; agrarian contracts; credit and microfinance; nutrition and health; poverty traps; etc. PPS 128 prerequisite or instructor approval. Instructor: Bellemare. 3 units. C-L: Economics 232S

233. 9/11: Causes, Response & Strategy. Examination of the origin and ideology of al-Qaeda and affiliated organizations, the events that led to the 9/11 attacks, and the public policy response in terms of use of force, preventive intelligence and law enforcement policies, and homeland security. Comparative examination of the efficacy and ethics of alternative counterterrorism policies. Instructor: Schanzer. 3 units. C-L: Political Science 233

234S. Making Social Policy. Examines the policymaking process, the role of different sectors in policymaking, policymakers’ use of research and communicating with policymakers. Focus on social policy. Includes experiential and written work as well as visits from policymakers and to policymaking events. Instructor: Owen. 3 units. C-L: Children in Contemporary Society 234S

237. Global Environmental Health: Economics and Policy. 3 units. C-L: see Environment 237; also C-L: Global Health Certificate 238

240. Responsible Genomics. Survey of ethical, social, economic, and legal issues in genomics. Introduction to ethical reasoning and examination of selected issues calling for such analysis, including: special procedures for research involving human participants, (2) respect for privacy and confidentiality of genetic information; (3) historical and political background of health research funding, and (4) public-private research interactions such as intellectual property and conflict of interest. Instructor: Cook-Deegan. 3 units


245. Counterterrorism Law and Policy. This course explores the novel legal and policy issues resulting from the United States' response to 9/11 attacks and the threat posed by modern terrorist organizations. Topics include preventative/preventive war; detention, interrogation, and prosecution of suspect terrorists; domestic surveillance; and government secrecy and public
251S. Regulation of Vice and Substance Abuse. The traditional vices of drinking, smoking, gambling, and the recreational use of drugs. Evaluation of government policy on these activities. The intellectual framework for evaluation drawn from economics, although readings refer to law, psychology, philosophy, and statistics. Instructor: Cook. 3 units. C-L: Economics 251S


254. Multidisciplinary Approaches to Global Health. Students are introduced to the multidisciplinary theories and techniques for assessing and addressing infectious, chronic, and behavioral health problems in less wealthy areas of the world. The course addresses global health issues from disciplines such as: epidemiology, biology, engineering, environment, business, human rights, nursing, psychology, law, public policy, and economics. For example, obesity can be examined in terms of: differential rates around the world; biological and psychological causes: environmental differences; ethics of subsidizing nutritious foods; policies limiting the availability of wealthy nation fast food; the economics consequences of the disease, and intervention. Instructor: Staff. 3 units. C-L: Environment 364

255. Health Policy Analysis. Group analysis of a current health-policy problem. Project involves background research, data acquisition, analysis, writing, and presentation of a substantial policy report. Designed for candidates seeking the undergraduate certificate in health policy. Consent of instructor required. Instructor: Conover or Taylor. 3 units. C-L: Health Policy 255

256. Global Health Ethics: Interdisciplinary Perspectives. 3 units. C-L: see Global Health Certificate 251

257S. United States Policy in the Middle East. From World War II to the present with a focus on current policy options. Instructor: Kuhnholm. 3 units. C-L: History 296S

258S. International Environmental Regimes (B, D). 3 units. C-L: see Political Science 271S; also C-L: International Comparative Studies 201CS

261. Evaluation of Public Expenditures. Basic development of cost benefit analysis from alternative points of view, for example, equity debt, and economy as a whole. Techniques include: construction of cash flows, alternative investment rules, inflation adjustments, optimal timing and duration of projects, private and social pricing. Adjustments for economic distortions, foreign exchange adjustments, risk and income distribution examined in the context of present value rules. Examples and cases from both developed and developing countries. Instructor: Conrad. 3 units. C-L: Economics 261, Environment 272

262S. Seminar in Applied Project Evaluation. Initiate, develop, and perform a project evaluation. Range of topics include measuring the social cost of deforestation, the B1 Bomber, a child nutrition program, the local arts program. Prerequisite: Economics 285 or Public Policy Studies 261. Instructor: Conrad. 3 units. C-L: Economics 262S

263S. Public Health Research Methods and Issues. Focus on prevention of diseases and health problems; funding, policy, and management decision making. Overview of public health interventions and outcomes in United States, Europe, and less industrialized nations. Emphasis on understanding the social construction of race and ethnicity and the impact of socioeconomic variables such as race, ethnicity, gender, income and education on health. Public health perspective applied to such topics as: HIV/AIDS; teen pregnancy; cocaine use during pregnancy; infant mortality and low birth weight; violence; major causes of mortality in less industrialized countries; and role of public health in state and national health reform. Instructor: Whetten. 3 units.

264. Advanced Topics in Public Policy. Selected topics. Instructor: Staff. 3 units.

264S. Advanced Topics in Public Policy. Selected topics. Seminar version of Public Policy Studies 264. Instructor: Staff. 3 units.

266S. Introductory Demographic Measures and Concepts. 3 units. C-L: see Global Health Certificate 250S

268. Media Policy and Economics. Use of economics to examine the production and consumption of information in communications markets and impact of media on society. Topics include regulation of television/radio/newspapers, intellectual property and Internet, content diversity, and news markets. Instructor: Hamilton. 3 units. C-L: Economics 235

269S. The Regulatory Process (A). Study of theories in economics, political science, and law to examine the structure, conduct, and performance of U.S. regulatory agencies. Emphasis on why decisions are delegated to agencies, the degree to which regulators behave strategically, and the impact of regulatory actions on society. Focus on political and economic roots of scientific and technological debates in regulatory policy. Required research paper on origins and effectiveness of a particular regulation. Instructor: Hamilton. 3 units. C-L: Political Science 268S

270S. History of Poverty in the United States. 3 units. C-L: see Study of Ethics 211S; also C-L: History 211S

271S. Schools and Social Policy. Overview and selected current policy issues related to K-12 education. Includes small-group research projects that require data analysis, literature searches, and interviews with education policy makers. Consent of instructor required. Instructor: Ladd. 3 units.

272. Resource and Environmental Economics. 3 units. C-L: see Environment 270; also C-L: Economics 270

272D. Resource and Environmental Economics and Policy (DISCUSSION). 3 units. C-L: see Environment 270D; also
272L. Resource and Environmental Economics. 3 units. C-L: see Environment 270L; also C-L: Economics 270L

274. Environmental Politics. 3 units. C-L: see Environment 274

278S. Race and American Politics (A). 3 units. C-L: see Political Science 278S; also C-L: African and African American Studies 278S

279S. Contemporary United States Foreign Policy. Focus on challenges and opportunities for American foreign policy in this global age including the impact of interests, ideals and values. Draws on both the scholarly literature and policy analyses. Addresses big picture questions about America's role in the world as well as major current foreign policy issues that raise considerations of power, security, prosperity and ethics. Open to undergraduates with permission of instructor and priority to Public Policy Studies and Political Science majors, and to graduate students. Instructor: Jentleson. 3 units. C-L: Political Science 279S

280S. Philanthropy, Voluntarism, and Not-for-Profit Management. An examination of the role and functioning of the not-for-profit sector in relation to both the public sector and the private for-profit sector in dealing with significant social problems. Also taught as Law 585. Instructor: Fleishman. 3 units.


284. Global Health Supply, Organization and Financing. 3 units. C-L: see Economics 284; also C-L: Global Health Certificate 284

286. Economic Growth and Development Policy. Basic principles and policy issues in the study of economic growth and development. The roles of physical, natural and human capital, technological innovation, productivity improvements and institutions in explaining patterns and causes of variations in growth and development performance of countries. Effects on growth and development of many current policy issues including HIV-AIDS, financial crises, foreign aid and investment, debt burdens and forgiveness, corruption and governance. Prerequisites: Public Policy 110 or Economics 149. Instructor: Fernholz, Glenday, or Shukla. 3 units. C-L: Economics 286

290S. Glasgow Seminar in Public Policy. Analysis of the British political system and important public policy problems in Britain including: privatization, Britain and the European community, and economic and social policy. (Taught in Scotland.) Prerequisite: Public Policy Studies 55D, two of the core courses (Public Policy Studies 114, 116, 128 or equivalent, or Statistics 101), and consent of director Instructor: Staff. 3 units.

303. Policy Analysis I. Introduction to policy analysis and advising. Emphasis on written and oral communication skills, the substance of public policies, and the role of policy analysts. Open to public policy studies MPP students only. Instructor: J. Johnson, T. Taylor. 3 units.

304. Policy Analysis II. The role and influence of policy analysis. The examination of specific public policy cases and recommendations for action. Emphasis on written and oral communications skills. Open to public policy studies MPP students only. Instructor: J. Johnson. 3 units.

306S. Special Topics in Public Policy. Selected topics. Prerequisite: graduate level. Instructor: Staff. Variable credit.

307. Master's Project I. Emphasis on individual or group projects. Preparation for Master's Project. Open to Public Policy Studies MPP students only. Prerequisite: for 308 Public Policy Studies 307 or consent of instructor. Instructor: Staff. 3 units.

308. Master's Project II. Emphasis on individual or group projects. Preparation for Master's Project. Open to Public Policy Studies MPP students only. Prerequisite: for 308 Public Policy Studies 307 or consent of instructor. Instructor: Staff. 3 units.

309. Master's Project Completion for Dual Degree Students. This is a no-credit course created for dual degree MPP students who were admitted August 2007 or before under the 30 credit program agreement. Students registering for this course will complete their Master's Projects under the supervision of a Sanford School faculty advisor, but will not receive graded credit for their projects. This course will charge a flat fee for each student registered. Instructor: Staff. 0 units.

310. Microeconomics and Public Policy-Making. Consumption and production theory, welfare economics, theories of collective choice, market structures and regulation, and nonmarket decision making. Not open to students who have taken Public Policy Studies 110. Graduate status only. Instructor: Clotfelter or Ladd. 3 units.


312. Statistics and Data Analysis for Policy Makers. The purpose of this course is to ensure that students are both critical consumers and effective producers of statistical evidence presented in support of policy arguments. Upon completing this course, students will have the capacity to analyze and evaluate arguments based on simple descriptive statistics, correlation, or multiple regression analysis. Students will also receive hands-on training in the creation of convincing statistical reports, from manipulating large datasets to conducting sensitivity analysis and presenting results. Instructor: Frankenberg or J. Vigdor. 3 units.

313. Quantitative Evaluation Methods. Problems in quantifying policy target variables such as unemployment, crime, and
poverty. Experimental and nonexperimental methods for evaluating the effect of public programs, including topics in experimental design, regression analysis, and simulation. Graduate status only. Prerequisite: Public Policy Studies 222 or equivalent. Instructor: Cook or Gassman-Pines. 3 units.

314. The Politics of the Policy Process. The formulation of public policies, substantive policies in a variety of contexts from local government to international affairs; the role of legislatures, interest groups, chief executives, and the bureaucracy in defining alternatives and in shaping policy from agenda formulation to implementation. Graduate status only. Instructor: Goss, Krishna, or Mayer. 3 units.


316. Ethics and Policy-Making (A). Normative concepts in politics, liberty, justice, and the public interest; historical and philosophical roots, relationship to one another and to American political tradition, and implications for domestic and international problems. Not open to students who have taken Public Policy Studies 116. Graduate status only. Instructor: Charny or Pickus. 3 units. C-L: Political Science 319


320. Globalization and Governance. Seminar explores economic, political, and social aspects of globalization and their implications for public policy making in the twenty-first century. Focus on issues of governance, particularly international cooperation, the design of international organizations, and the role of international NGOs. Policy areas include international trade and finance, environment, security, human rights, media and communications, and international development. Instructor: Jentleson or Mayer. 3 units.

325. Topics in Health Policy. Seminar introduces students to major health policy concepts and methods of analysis of health policy problems. Focus on domestic and international health policy topics, including: nature of disease, health and economics, health care delivery systems, demography and health. Consent of instructor required. Instructor: D. Taylor. 3 units.

330. Special Topics in Leadership and Management. Selected topics. Prerequisite: graduate level. Instructor: Staff. 1.5 units.

340. Advanced Special Topics in Public Policy. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

341. Advanced Special Topics in Public Policy. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. Variable credit.

345. Racial and Ethnic Minorities in American Politics. 3 units. C-L: see Political Science 316; also C-L: Law 597

350. Special Topics in Social Policy. This course will introduce students to the major methods used in the analysis of problems in social policy. These methods derive from economics, political science, human development, ethics, and systems analysis. Students will learn to apply these methods to contemporary problems. Students will learn to think critically, analytically, and synthetically. Students will write critical reactions, policy briefs, and opinion papers. Class time will be devoted to lectures, student discussion of readings, oral presentations by students, and occasional guest speakers. Instructor: Gibson-Davis. 3 units.

360. Special Topics in Global Policy & Governance. This course seeks to explore some central questions of global policy and governance. Taking advantage of its location in Geneva, it provides students with an opportunity to experience the real world of international diplomacy, to access key actors and institutions involved in global policy processes, and to think critically about the international system today, and what it might become. It is designed to give students access to a range of international organizations, and to develop the skills knowledge and contacts necessary to enter a career in international affairs. Consent of instructor required. Instructor: Staff. Variable credit.

380. Policy Analysis of Development. The broad objectives of this seminar are: 1) to examine the role of policy analysis in solving important social problems; and 2) to develop the analytical and communication skills of participants in order to undertake effective policy analysis. This seminar examines public policy objectives and the role of policy analysis in achieving these objectives, market and government failures, the role of the public and private sector, policy analysis tools (e.g. cost-benefit analysis, decision analysis, etc.), and policy implementation and evaluation. Emphasis is given to specific policy problems (e.g. social, environmental, health problems) based on the interests of the participants. This seminar relies on case studies, application of policy analysis tools, exercises, memos, policy critiques, and discussions with policy analysts. At the end of the semester participants should be able to understand policy issues and choices, why policies fail, how to use policy tools to reach decisions, and how to evaluate policies. Instructor consent required. Instructor: N. Mirovitskaya or R. Fernholz. 3 units.

381. Economic Foundations for Development. This course is an overview of microeconomic and macroeconomic principles related to development. The objective of the course is to provide analytical tools for the study of economic policies and problems in developing countries. The seminar includes presentation of theoretical material and its application to current topics and problems. Instructor consent required. Instructor: Krupp. 3 units. 3 units.

382. Economic Analysis for Development. This course provides a survey of basic principles and policy issues in the study
of economic growth and development. As such, it is a foundation course for any student of development theory or practice. It provides an overview of patterns and causes of variations in growth, income distribution and development performance of countries. The roles of physical, natural and human capital and technological innovation and productivity improvements in explaining growth are explored with the effects of different institutional environments in less developed and transitional economies. With this framework, the seminar will explore economic growth and development in policy areas including: theory and history of economic development, institutions and the role of the state in economic development, governance, corruption and development, population, public health and development, environment and sustainable development, education and women in development, investment and fiscal policy, foreign aid, debt relief and financial crises, trade and industrial policy; protection and export promotion, agricultural policy and development, and technology, globalization and development. Instructor consent required. Instructor: F. Fernholz. 3 units.

383. A-C. Development Management Courses - International Development Policy. A. Institutional Design for Managing the Environment B. Managing the Project Cycle C. Strategic Management for Policy Change. Courses cover areas of development project management, entrepreneurship development, not-for-profit management, civil society and governance, decentralization, media policy, aid coordination, science and technology policy, regional planning, rural or urban development, or other sector development issues. For complete course descriptions, see http://www.pubpol.duke.edu/centers/dcid/pipd/masters.html. Instructor: Lethem (383A,B), Van Sant (383C). Variable credit.

383A. Institutional Design for Sustainable Development. The objective of this seminar is to explore organizational and institutional design theory and its application towards promoting a more sustainable development. The seminar is structured to deal with the macro and micro institutional levels; structures and processes, including interagency coordination; and policy and implementation issues. Intensive use is made of case studies from various sectors in developing and transitional countries, though with emphasis on environmental management issues. As a seminar product, participants are expected to apply tools they have acquired to an institutional design problem of their choice that would be relevant to the management of the environment or any sector in which they have a special interest in their preferred country. Instructor consent required. Instructor: F. Lethem. 2 units.

383B. Managing the Project Cycle Toward Sustainable Development. This seminar examines the substantive and institutional aspects of the design, appraisal, and implementation of development projects to ensure their sustainability and mitigate the risks of conflict. It is intended for future senior officials in the Planning Agency of a developing country, project officers in international lending institutions, and project officers in humanitarian agencies. Topics covered include the elements of the enabling environment necessary for project sustainability (such as the environmental and social impact of macroeconomic policies, issues of governance, public accountability, and the role of the public versus the private sector), the design of sector strategies, the ingredients of individual project quality sustainability, the project generation and implementation process, and the management of a country's public investment program. Fellows specializing in conflict prevention will be asked to give special consideration to factors such as equity, local participation, and human rights. This seminar is structured around practical case studies, and participants are expected to prepare a seminar project on one of the seminar topics that would be particularly relevant to promote the sustainability of their preferred country's public investment program. Instructor consent required. Instructor: F. Lethem. 2 units.

383C. Strategic Management of Policy Change. This seminar examines the complex environment for policy change and explores management and organizational strategies to assure effective implementation of policy initiatives. Among the issues covered are leadership, strategic planning, change management, environmental mapping, organizational capacity-building, policy advocacy and constituency-building, performance monitoring, and sustainability. We also will explore how new information technologies can be used to facilitate policy dialogue and policy support. The seminar builds on the premise that management and organizational factors play a major role constraining (or promoting) effective policy implementation. A further assumption is that participants will have important leadership opportunities in the course of their future careers. There are management skills and techniques that can increase your ability to accomplish personal goals and those of the public or private agencies in which you serve. The seminar stresses mutual learning through the practice of teamwork and effective oral presentation of team learning. These will be important skills in your future careers. This emphasis also reflects the assumption that we have much to learn from each other. Instructor consent required. Instructor: F. Vansant. 3 units.

383D. Poverty Reduction and the International Financial Institutions. Over the last 50 years, development and poverty reduction have been the twin concerns of the International Financial Institutions (the World Bank, the International Monetary Fund (IMF) and the regional development banks). The course will trace the evolution of international poverty reduction theory, policy and implementation from the emphasis on capital accumulation and large infrastructure projects in the 1960s to the integrated rural development programs and basic needs approaches of the 1970s, through structural adjustment and sectoral programs in the 1980s and 1990s, to today’s emphasis on debt relief and Poverty Reduction Strategies. As these changes were happening, related changes also were taking place in the structures, policies, and practices of the IFIs. The course will, look at the rationale, basic features, and effectiveness of each poverty reduction approach, as well as the accompanying changes in the two principal IFIs, the World Bank and the IMF. The course will use general studies and reviews, as well as actual project and program examples. The course is primarily a group discussion, with occasional mini-lectures and student presentations. Written requirements include a mid-term assignment and final paper. Instructor consent required. Instructor: Phyllis Pomerantz. 3 units.

383E. The Politics of International Aid in Low-Income Countries. This course will examine the evolving context,
objectives, and results of international development aid in the post World War II period, with an emphasis on the period from the 1980s through today. It will review the track record of aid and lessons thus far, and the reform proposals for change currently under discussion in the international community. Attention will be focused on the principal stakeholders, their motivations and capacity, and the quality of interaction among the various players (governments, bilateral donors, multilateral institutions, and NGOs). It will also evaluate the results achieved and the prospects for future success. Special reference will be given to Africa, the center of much of the evolving debate surrounding aid effectiveness. The course is primarily a group discussion, with occasional mini-lectures, student presentations, debates, case studies, and a final simulation exercise. Instructor consent required. Instructor: P. Pomerantz. 3 units.

383F. The Role of Global Programs in International Development. Global programs have emerged as an increasingly important element in international development efforts. This seminar will examine and contrast different types of global programs, including those involving global public goods and those centering on global advocacy. The course will: explore the complexity of defining global public goods; trace the evolution and motivations for global programs in general and several of the programs in particular; examine how selected programs are managed, financed, and functioning in practice; and analyze the emerging contradictions and/or complementarities between global programs and country-specific development strategies and programs. Class sessions will include individual and/or small group presentations. Students will also select a prominent global program and examine if and how the program is contributing to overall development efforts within a specific country/subregional setting. Instructor consent is required. Instructor: P. Pomerantz. 3 units.

383G. Innovative Policies. Innovative approaches are increasingly seen as key to solving difficult and novel challenges in our century, whether these challenges are local survival in the face of persistent droughts or boosting productivity to meet global competition. These policy innovations or the frameworks that encourage innovation and entrepreneurship have to be crafted and sustained by informed public policy makers. This course will focus on the analytical tools and skills needed by policy makers to build and sustain an enabling policy environment for innovations to occur at global, country and local levels. The questions we will explore are: How can governments create a momentum for innovation that can involve and motivate different sectors of the economy and society? How can innovation be effectively linked to improvements in overall societal goals such as improved wellbeing and productivity? The course will use the case study approach to discuss concepts and to examine a range of policies and programs that highlight some important factors. Our case studies will come from history such as the Marshall Plan and from contemporary times such as learning and the $100 laptop. Active participation, class presentations and a final paper or project are required. Instructor consent required. Instructor: R. Fernholz. 3 units.

383H. Service Delivery Systems. What happens to policy after laws are made, budgets are approved, and either public or nonprofit agencies try to implement public policy? This course will provide students with a way to understand the issues involved in delivering services to the public at the "street level". It will also give students an overview of a wide variety of services including: child protective services, education, law-enforcement, mental-health, juvenile-justice, public health, and other services that government, and increasingly non-profit and for-profit organizations, try to deliver to the public. Consent of instructor required. Instructor: Staff. 3 units.

383I. Monitoring and Evaluating. This course takes a critical look at the range of issues and challenges typical in program M&E, with a strong focus on international development programs or projects. Students will develop or strengthen key program design and management skills for stronger results and demonstrated impact. Hands-on practical assignments will draw on material presented, your own experience, and class discussions to test your ideas and constructively challenge others. Half of the class grade depends on a group or individual project (M&E design and case study). Requirements: Experience in international development programs, comparable practical exposure to real-world low-resource political economies, or professor’s approval. Logic or philosophy of science, and social science analytical methods. Instructor consent required. Instructor: J. Tham. 3 units.


384A. Empirical Analysis for Economic Development. The overall goal of this course is to enable decision makers in the public sector to be judicious and critical consumers of research results. In particular, we focus on issues in developing countries, where the availability of the data may be sparse and the quality of the data may be suspect. With high quality data, the conclusions of the analysis may be ambiguous. With low quality data, there is a greater need for caution in the interpretation and derivation of the appropriate policy recommendations. "Empirical analysis for economic development" has three key objectives. First, the course provides a non-technical introduction to basic concepts in empirical analysis, namely regression modeling with single and multiple variables. Second, it uses EXCEL and SPSS, a widely-used software package, to illustrate, practice and apply the techniques of regression analysis. Thirdly, it enables the participants to read and assess the quality of the empirical analyses and results that are used in reports. Instructor consent required. Instructor: J. Tham. 3 units.

384B. Public Finance in Developing and Emerging Economies. Covers the basic theory, policy and practice of public finance in these economies. It examines the economic roles and rationale for government and potential methods of financing government. The nature of fiscal policy and its relationship to macroeconomic policy is examined, including issues of foreign
aid, debt financing and inflation. The course analyzes the approaches to pricing, financing and evaluating public sector outputs such as roads, water, education and electricity. It then reviews and analyzes taxes on trade, consumption, income, property and natural resources considering their economic efficiency and administrative costs and distributional impacts. Methods and importance of forecasting revenues are presented. Special topics include the design and role of tax incentives and environmental taxes. Instructor consent required. Instructors: G. Glenday, G. Shukla, F. Fernholz. 3 units.

384D. Comparative Tax Policy. This course is required for ITP fellows. Investigates in detail the design and policy options in the major taxes on consumption and income, comparing these taxes across countries. The impacts of these tax designs on revenues, economic efficiency, administrative and compliance costs and income distributions are considered. The course reviews the principles of taxation, including those used in allocating taxes to the multiple levels of government in the context of decentralization and across states in common markets or federal systems. In the area of consumption taxes, the course focuses in detail on value-added taxes and general goods and service taxes, but turnover and selective sales taxes are also considered. For income taxes, detailed design features covered include the definition of income, capital gains, employment benefits, business expenses, accounting conventions, inflation indexation, tax integration, international tax harmonization, transfer pricing, thin capitalization and tax incentives. For all taxes, issues of the treatment of small businesses and the informal sectors are featured. This course follows PUBPOL 384B, Public Finance in Developing and Emerging Economies, but can also be taken by students with appropriate backgrounds in public finance or taxation. Instructor consent required. Instructor: P. Pomerantz. 3 units.

384E. Comparative Tax Administration. This course is required for ITP fellows. Reviews modern approaches to tax administration for both border and domestic taxes, and compares approaches across countries. The course covers all the major functions of tax administration, considering legal, technical and managerial issues. The trends in tax administration toward a greater degree of self assessment, and toward functional and client-oriented organization are themes throughout the course. In addition, new trends and techniques are highlighted, including computerization and e-governance, the design of risk-weighted random audit selection, and valuation and transfer pricing issues. The organization of tax administration is a core issue, including the use of revenue authorities and the legal frameworks underpinning tax administration and organization. Finally, tax reform experiences are reviewed, including planning and change management. Instructor consent is required. Instructors: G. Glenday and G. Shukla. 3 units.

384F. Fiscal Policy, Globalization, and Development. This course examines the fiscal management challenges facing emerging market and developing countries as they pursue growth and macroeconomic stability. Fiscal discipline is crucial, and in this connection the course will cover: a macroeconomic framework that can be used to examine the payoff to fiscal discipline; the complications created by international spillovers and efforts to promote policy coordination; and policy options and institutional reforms available to countries trying to restore and maintain sound fiscal positions. The course also examines some specific fiscal management issues facing many countries, including: infrastructure financing, financial sector bailouts, fiscal stabilization, capital flow volatility, aid and debt relief, natural resource management, entitlement reform, and climate change. The course blends economic, policy, and institutional analysis in a rigorous but none technical manner. Case studies will focus on challenges faced and policies adopted by selected countries or groups of countries, including some industrial countries where there are clear lessons for emerging market and developing countries. Instructor consent is required. Instructor: Staff. 3 units.

384G. Economic Principles for Public Finance. Examines the principles of microeconomics and macroeconomics required for the analysis and forecasting of taxes and expenditures. The microeconomic component covers basic market principles with a focus on the applied welfare economics necessary for public finance analysis. Accounting conventions underlying costs and profits are examined. The impacts of taxes, subsidies and other policies on domestic and international markets are studied. The macroeconomic component covers national accounting aggregates and input-output structures of an economy and relates them to the structure and growth of tax bases. The relationships between savings, investment and growth are examined. The effects of government expenditure, revenue and deficit policies on the balances in the domestic and international financial and trade markets are introduced. Instructor consent required. Instructor: Staff. 3 units.

384H. Analytical Methods for Public Finance. Covers the quantitative analytical methods and tools required in public financial analysis, forecasting of revenues and public expenditures and statistical analysis. Microcomputer-based packages and techniques for handling, analyzing, modeling and presenting revenue and expenditure data and analytical results are reviewed. Modeling and statistical methods are studied to assist in the analysis and forecasting of growth in the economy, expenditure and revenues, and the distributional impacts of revenues and expenditures, including the building of databases for, and the use of, micro-simulation models. Consent of instructor required. Instructor: Staff. 3 units.

384I. Public Budgeting and Financial Administration. Focuses on the policies, procedures, and skills needed for effective budgeting and financial management in the public sector. Core topics to be covered in the course include budget systems and controls, public sector accounting and costing, financial reporting for accountability, and capital budgeting and debt management. The course provides the analytical skills needed to understand the links between budgeting and the macro-fiscal framework, the political decision-making process, and the interests of citizens. The emphasis is on the theory and international practice of budgeting, with particular application to developing countries. Issues of program and performance budgeting, participatory budgeting and citizen accountability, and decentralized fiscal systems will be discussed. Consent of instructor required. Instructor: Staff. 3 units.
384K. Fiscal Decentralization and Local Government Finance. Focuses on analyzing policy and administrative options to effectively empower local governments to improve service delivery, economic governance and citizen participation. The course covers the theory and practice of fiscal decentralization with detailed analysis on the four pillars of rationalizing central-local expenditure and revenue responsibilities, designing effective intergovernmental transfers and structuring local borrowing. Special attention will be paid to the practical aspects of designing and implementing effective decentralization reforms to improve efficiency and accountability within the public sector. Consent of Instructor required. Staff: Instructor. 3 units.

285. Land Use Principles and Policy. 3 units. C-L: see Environment 285


385E. International Development, Conflict and Cooperation: Crucial Linkages. Empirical research suggests strong linkages between dynamics and patterns of development and inequality and instability. The absolute majority of violent conflicts throughout the globe today are fought within developing nations-among communities divided along ethnic, religious, linguistic/cultural, and/or geographical lines. However, though many scholars and practitioners recognize that development and conflict are intertwined, there is much less understanding (or at least consensus) about the mechanisms behind these linkages. And there is even less understanding of the economic development patterns that can create conditions of the peaceful coexistence of different elements of the population and encourage their cooperation. The course aims to address this challenge by critically examining the institutional frameworks and human capacities needed to further "freedom from fear" and "freedom from want". We will pay particular attention to which economic development strategies create conditions conducive to inter-group violence or peaceful coexistence, especially in developing and transitional countries. Students will learn some key concepts and different analytical frameworks in the field of conflict and cooperation as well as development studies. Class discussion will also focus on the role of development assistance in provoking or mitigating conflicts and in promoting cooperation. Instructor consent required. Instructor: N. Mirovitskaya. 3 units.

385H. Human Rights and Conflict. One story of the relationship between human rights and conflict is told in the Preamble to the UN Charter: the human rights framework of our age came about because of the 20th century's two world wars. But for the "untold sorrow" brought about by these conflicts, so the story goes, there would have been no effective demand for and no construction of a set of legal, political and ethical norms intended to help "save succeeding generations from the scourge of war". In this course we will examine the link between human rights and conflict in an interdisciplinary fashion. What are the multiple ways in which the law and political advocacy of human rights relate to conflict? Do demands for human rights precipitate or fuel as much as prevent-conflicts, whether as war or in other forms of large scale suffering? Are human rights essential for what the field of conflict resolution has termed "positive peace"? Should policymakers involved in multiple stages of conflict, both inter-and intrastate, be more cautious about viewing rights as a remedy for conflicts? What are relevant ethical considerations? With the benefit of greater analytical and contextual understanding of competing priorities and tradeoffs, what positive role might be cast for human rights in the conflicts of the 21st century? To consider these and other questions, we will draw substantially on historical and policy analyses, learning the legal/political history of the contemporary framework for human rights and connecting it to real world efforts underway by lawyers and other practitioners to reframe and transform conflict and build peace. Consent required by instructor. Instructor: Staff. 3 units.

385J. Culture, Policy, and Action. Starting with the premise that 'culture matters', the course covers the impacts of values and attitudes, historical differences, religion, ethnicity, language, and regional identities to shape public policy, action and debate. It draws insights from various disciplines such as history, anthropology, sociology, economics, natural sciences, politics and religion. During the semester, we discuss approaches to value cultural diversity, culture relevant dilemmas in development, policy making by various actors in divided societies, and the cost of culture related difficulties. Fellows enrolled in the course are expected to participate actively through class discussions/debates and presentations. There will be group presentations (2-3 persons to a group) made on selected themes during the course. A major paper on the topic presented is also required. Consent of Instructor required. Instructor: Staff. 1.5 units.

385K. Indigenous Peoples, Human Rights, and Development. This seminar focuses on indigenous peoples, their basic rights, and their roles in national and international development processes. Through class discussions, case studies and role-playing, students will examine the impact of national policies and global trends on indigenous populations and vice versa, and the dynamics of conflict generation and resolution. Among the issues to be discussed are notions of sovereignty and governance, land and other property rights, community management of natural resources, indigenous social movements, international networks and assistance, culture, access and survival. This seminar is designed for graduate students from diverse fields such as public policy, environmental science, law, religion, education and business, who are concerned with international development issues and processes. Fellows enrolled in the course are expected to participate actively in class sessions and to read the course materials. W will have class discussions of theories relevant to power and participation, case studies, and role playing. Fellows will be required to submit short individual policy papers and one major group paper which will also be
presented in class. Consent of instructor required. Instructor: Staff. 1.5 units.

385L. *Introduction to Law and Development.* If American academic lawyers (untrained in development) and "values-exporting" politicians brought the "Law and Development" movement into vogue in the 1960s, only to declare failure in the 70s, in the last decade of the 20th century, a cosmopolitan set of (untrained in law) development economists, economic historians and political scientists revived the coupling of these fields. Following their lead, lawyers and policymakers across the development board-from the World Bank, to bilateral aid agencies, to developing countries and to civil society organizations like Oxfam and more locally based institutions-have returned to the multi-disciplinary enterprise. Does law matter to development outcomes? Or, put another way, is "legal development" integral to the "development process"? If so, why and how? What policy ideas can or should be pursued on an understanding of the intersections between law and development? What research and policy initiatives are currently underway in the name of this intersection? Because all these questions depend on contested ideas of development and of law in the first instance, what is the array of working definitions and frameworks that practitioners and policymakers deploy? What turns can we anticipate the "law and development" field might take next? With readings by lawyers, policymakers, economists, anthropologists, ethicists, political and other social scientists, this seminar will explore contemporary understandings of law and development from "rule of law" to "good governance" to "doing business" and promoting capitalism to "judicial and legal reform" to promoting "J4P" (justice for the poor) to breaking-or at least not reinforcing-"poverty and inequality traps" and empowering the poor. The course is intended for graduate students (with and without legal backgrounds) interested in probing or promoting this interdisciplinary engagement. Consent of instructor required. Instructor: Staff. 3 units.

386. *Independent Research Topics in International Development Policy.* Selected topics. Consent of instructor required. Instructor: Staff. Variable credit.

387. *Master's Project in International Development Policy.* Emphasis on individual projects. Open to PIDP students only. Consent of instructor required. Instructor: Staff. Variable credit. Variable credit.

388. *Special Topics in International Development Policy.* Variable topics on International Development. Current offerings include: Human Rights and Conflict (3 units), Law and Development (3 units), Monitoring and Evaluation for Policy and Project Success (3 units), Fiscal Policy, Globalization and Development (3 units), Indigenous Peoples, Human Rights and Development (1.5 units), Culture, Policy and Action (1.5 credits), Capacity Development (1.5 credits). Instructor: Staff. Variable credit.


390. *Masters Project Preparation.* This one-credit mandatory seminar is intended to facilitate efficient preparation of the master’s project. It focuses on preliminary preparation up to prospectus defense. The seminar reviews lessons from past experience, selection of topic, and development of a research plan as well as the key elements of the policy analysis methodology. Grading is based on participation and the quality of the final prospectus. Consent of instructor is required. Instructor: Staff. 1 unit.


501. *Political Economy of Public Policy.* Introduces PhD students to core set of social science ideas relevant to public policy: theories of collective action, institutions and governance. Provides students with a framework for evaluating market, political and social failures; identifying possible policy interventions; and predicting ways in which such interventions would translate into policy outcomes. Consent of department required. Instructor: Mayer, Cook, or Pfaff. 3 units.

502. *Ethics of Public Policy.* Introduces PhD students to normative frameworks for evaluating public policies and governance processes drawing on social choice theory, political theory and social theory. Provides students with normative and analytical bases to evaluate the public good, tradeoffs between efficiency and equity, political legitimacy and justice. Consent of department required. Instructor: Mayer, Cook, or Pfaff. 3 units.


509. *Dissertation Proposal Seminar II.* Required seminar for all 3rd year PhD students in Public Policy preparing to make a dissertation proposal. Prerequisite: Pubpol 508. Instructor: J. Vigdor. 3 units.

540. *Advanced Special Topics in Public Policy.* Contents and methods vary with instructors and from semester to semester. Consent of department required. Instructor: Staff. 3 units.

**Religion**

Professor Jaffe, *Chair* (123A Gray); Professor Wacker, *Director of Graduate Studies* (209A Gray); Professors Chaves, Clark, Davis, Fulkerson, Griffiths, Hauerwas, Hays, Hillerbrand, Hueter, Jones, Kort, Lawrence, Lischer, Maddox, Marcus, C. Meyers, E. Meyers, Morgan, Peters, Surin, Van Rompuy, Verhey, Wainwright; Associate Professors Campbell, Carter, Chapman, Goodacre, Hall, Jennings, Keeve, Moosa, Nickerson, Prasad, and Smith; Assistant Professors Hassan, Kim, Lieber, Pak, Portier-Young, and Rowe; Associate Professor of the Practice Turner; Assistant Professor of the Practice Eastman

The Graduate Program in Religion offers graduate work in numerous programs leading to the AM and PhD degrees. Students may concentrate their studies in one of the following fields of study: Hebrew Bible/Old Testament, New
Students will be expected to take courses that will contribute to an understanding of their field of specialization and will be required to take two written preliminary examinations within that field. In addition to course work in their major field, students will take courses in minor fields that will contribute to the enrichment of their major studies and will be required to take one written preliminary examination in a single cognate area within the program. A minor requirement may be fulfilled in the program or by work in a cognate department or program, such as Women’s Studies, English, History, Literature, Philosophy, Political Science, or Sociology, and will constitute the outside minor and material for a fourth written preliminary examination. There is, in addition, an oral examination conducted by the student’s committee shortly after the written examinations. Foreign language requirements determined by the faculty in the field of specialization must be met before taking the doctoral preliminary examination.

The program of doctoral studies normally presumes a foundation in the academic study of religion. Students applying for graduate work in religion directly from an undergraduate program should possess a strong undergraduate major in religion or a closely related field.

For more information, visit the Graduate Program in Religion’s Web site, http://www.duke.edu/web/gradreligion/ or e-mail, lisa.bradrick@duke.edu.

Religion Courses (RELIGION)

201. Studies in Apocrypha and Pseudepigrapha. Selected documents of the Apocrypha and Pseudepigrapha examined exegetically and theologically in their relation to postexilic Judaism. Instructor: Staff. 3 units.


203. Origen. The systematic and apologetic writings of an important Alexandrian thinker and exegete of the third century. Instructor: Clark. 3 units. C-L: Medieval and Renaissance Studies 204

204. The Christian Mystical Tradition in the Medieval Centuries. Reading and discussion of the writings of medieval Christian mystics (in translation). Each year offers a special focus, such as: Women at Prayer; Fourteenth-Century Mystics; Spanish Mystics. Less well-known writers (Hadewijch, Birgitta of Sweden, Catherine of Genoa) as well as giants (Eckhart, Ruusbroec, Tauler, Suso, Teresa of Avila, Julian of Norwich, Catherine of Siena, and Bernard of Clairvaux) are included. Also offered as Church History 206 and Medieval and Renaissance Studies 206. Instructor: Keefe. 3 units.

205. Hebrew Prose Narrative. Focus on the grammar, syntax, and prose style of classical Hebrew composition; a comparative reading of modern and precritical Jewish and Christian commentary. Readings spanning the spectrum from the early Hebrew prose of Genesis and I and II Samuel to the late compositions of Chronicles and Ezra-Nehemiah. One year of classical Hebrew required. Consent of instructor required for undergraduates. Also taught as Old Testament 207. Instructor: Chapman, Davis, Peters, or Portier-Young. 3 units. C-L: Jewish Studies 201

207. Hebrew Prose Narrative. Focus on the grammar, syntax, and prose style of classical Hebrew composition; a comparative reading of modern and precritical Jewish and Christian commentary. Readings spanning the spectrum from the early Hebrew prose of Genesis and I and II Samuel to the late compositions of Chronicles and Ezra-Nehemiah. One year of classical Hebrew required. Consent of instructor required for undergraduates. Also taught as Old Testament 207. Instructor: Chapman, Davis, Peters, or Portier-Young. 3 units. C-L: Jewish Studies 201

208. Classical Hebrew Poetry: An Introduction. The problem of defining and understanding what is "poetic" in classical Hebrew. Theories of Hebrew poetry from Lowth to Kugel and O'Connor illustrated with readings from Psalms, Isaiah, Job, and Jeremiah. One year of classical Hebrew required. Consent of instructor required. Also taught as Religion 208. Prerequisites: OLDEST 115, 116. Instructor: Chapman, Davis, Peters, or Portier-Young. 3 units. C-L: Jewish Studies 202

212S. Theorizing Religion. Late nineteenth- and twentieth-century theories, interpretations, and approaches to the study of religion. Instructor: Staff. 3 units.

214. Feminist Theology. Examination of feminist theologians and religionists, their critical perspective on the Christian tradition and constructive proposals out of the resources of "female experience." Instructor: Fulkerson. 3 units.

215. Biblical Interpretation in Early Christianity. How early Christian writers of the second—mid-fifth centuries made meaning of the Scriptures in their own, postbiblical environments. Focus on the new historical, religious, and theological situations that required new readings of scriptural texts, the role of heresy and the ascetic movement in the development of biblical interpretation and canon development, and special problems that arose around these issues. Instructor: Clark. 3 units.

216. Elementary Syriac. Introduction into the language; reading and analysis of simple texts. Instructor: Van Rompay. 3 units.


220. Rabbinic Hebrew. Interpretive study of late Hebrew, with readings from the Mishnah and Jewish liturgy. Consent of instructor required for undergraduates. Instructor: E. Meyers or staff. 3 units. C-L: Jewish Studies 203

221. Readings in Hebrew Biblical Commentaries. Selected Hebrew texts in Midrash Aggadah and other Hebrew commentaries reflecting major trends of classical Jewish exegesis. Consent of instructor required for undergraduates. Instructor: Staff. 3 units. C-L: Jewish Studies 204


227F. **Exegesis of the Greek New Testament II: The Synoptic Gospels.** Concentration on the "classical" methods of studying the first three gospels: source criticism, form criticism, and redaction criticism. Some attention to textual criticism. Students expected to become proficient in using the Greek synopsis. Prerequisite: two years of Greek or the equivalent. Consent of instructor required. Instructor: Goodacre. 3 units.

227H. **Exegesis of Greek NT II: Hebrews.** Consent of instructor required for undergraduates. Instructor: Hays. 3 units.


234. **Early Christian Asceticism.** The development of asceticism and monasticism in the first six centuries of Christianity. Instructor: Clark. 3 units. C-L: Medieval and Renaissance Studies 234A

236. **Luther and the Reformation in Germany.** The theology of Martin Luther in the context of competing visions of reform. Instructor: Staff. 3 units.

244. **Archaeology of Palestine in Hellenistic-Roman Times.** The study of material and epigraphic remains as they relate to Judaism in Hellenistic-Roman times, with special emphasis on Jewish art. Instructor: E. Meyers. 3 units. C-L: Jewish Studies 206

245S. **Special Topics in Religion.** Subject varies from semester to semester. Instructor: Staff. 3 units.

247. **Readings in Latin Ecclesiastical Literature.** Readings in Latin of pastoral, theological, and church-disciplinary literature from the late patristic and medieval period. Also taught as Church History 247 and Medieval and Renaissance Studies 247. Prerequisite: knowledge of Latin. Instructor: Keefe. 3 units.

248. **Sociology of Religion.** 3 units. C-L: see Sociology 230

250. **Women in the Medieval Church.** The history of the medieval Church told from its women figures: the life and writings of saints, heretics, abbesses, queens, mystics, recluses, virgins, bishops' wives, and reformers. Instructor: Keefe. 3 units.

254. **Justice, Law, and Commerce in Islam.** History and schools of Islamic jurisprudence; Islamic legal reasoning; approaches to ethics and procedural justice, the ethical regulation of commerce, including a detailed study of pertinent issues in Islamic law. Also taught as Law 568. Instructor: Moosa. 3 units. C-L: African and African American Studies 254, Medieval and Renaissance Studies 254

257. **New Testament Ethics.** The distinctive patterns of ethical teaching in the various New Testament writings and consideration of the various ways in which the New Testament might inform contemporary ethical reflection. Representative uses of the New Testament in theological ethics (for example, Niebuhr, Barth, Yoder, Hauerwas, Schussler, Fiorenza, Gutierrez) and selected topics (for example, violence, divorce, anti-Judaism, abortion, wealth, and poverty). Instructor: Hays. 3 units.

259. **Icon Theology.** A study of theological controversies surrounding the use of images in Christian worship, followed by an attempt to perceive the symbolic conventions and doctrinal content of some Eastern, Western, and contemporary icons. Instructor: Wainwright. 3 units.

260. **Life and Times of the Wesleys.** A seminar on John and Charles Wesley and their colleagues in relation to English culture and religion in the eighteenth century. Instructor: Staff. 3 units.

265. **Epics of India: Ethics, Politics, and Performance Traditions.** Wide variety of epics across linguistic, geographical, and community orientations. Moral discourses, literary theory relating to epic form, performance traditions and media representations of epic narrative, and connections between political ideology and epic visions. Consent of instructor required. Instructor: Prasad. 3 units. C-L: Asian & Middle Eastern Studies 210

270. **Evangelical Traditions in America.** A study of some of the major themes in the development of transdenominational evangelicalism and fundamentalism in America from the eighteenth century to the present. A reading seminar involving analyses and discussions of literature (mostly secondary works) important for understanding American evangelicalism as a distinct movement. Instructor: Wacker. 3 units.

272S. **Intermediate Syriac.** Continuation of reading and analysis of Syriac texts. Instructor: Van Rompay. 3 units.

273S. **Advanced Syriac.** Advanced reading and analysis of Syriac texts. Instructor: Van Rompay. 3 units.

276. **The Sacraments in the Patristic and Early Medieval Period.** A study of the celebration and interpretation of baptism or eucharist in the church orders and texts of the early church writers. Instructor: Keefe. 3 units.

278. **Muslim Networks Across Time and Space.** 3 units. C-L: see Asian & Middle Eastern Studies 254S

283. **Islam and Modernism.** Cultural, religious, and ideological forces that shape Muslim responses to modernism. Instructor: Staff. 3 units.

284. **The Religion and History of Islam.** Investigation of the historical study of Islam: historiography as a discipline, the historical study of Islam in the Western world, Muslim views of Islamic history. Required critical essays and major research paper. Instructor: Staff. 3 units.

285. **Freedom and Law.** Lecture course will explore the centrality of freedom and law to doctrine of God as well as to the
understanding of the human being and unfold their complex interrelationship in the traditions of theology and philosophy. Also taught as Christian Theology 285. Instructor: Huetter. 3 units.

288. Buddhist Thought and Practice. A historical introduction to Buddhist thought and practice, with special attention to their interrelationship in the living religion. Instructor: Jaffe. 3 units.


292. The Social Organization of American Religion. Addresses religion's formal and informal social organization. Examines how religion is organized, and explores causes and consequences of variation in religious social organization. Considers impact of demographic changes on American religion, and asks how ideas from study of social networks, formal organizations, and professions apply to religion. Instructor: Chaves. 3 units.

For Graduate Students Only

302. Theology of John Wesley. Critical examination of selected texts of John Wesley with attention to their social and cultural contexts. Instructor: Staff. 3 units.

303. The Old Testament in the New: New Testament Writers as Interpreters of Scriptures. This doctoral seminar examines the ways in which New Testament authors read and interpreted Scripture. Working knowledge of Greek and Hebrew required. Instructor: Hays. 3 units.

304. Aramaic. Study tests representing "Standard Literary Aramaic": Biblical, Qumran, and Targumic (Targum Onkelos). Other Aramaic language forms may be included. Prerequisite: Should preferably have elementary knowledge of Hebrew. Instructor: E. Meyers or Van Rompay. 3 units.


306. Advanced Syriac. Reading and study of Early Syriac Christian texts (2nd-7th) with a general introduction into scholarship on Syriac Christianity. Combination of class work and individual reading. Spring only. Instructor: Van Rompay. 3 units.

307. History and Theory. Explores debates among historians, philosophers, and theorists during nineteenth and twentieth centuries over the status of history as a discipline and as an intellectual enterprise. Particular attention given to the study of religious texts as an aspect of the "new" intellectual history. Seminar will seek to relate these discussions to students' respective sub-disciplinary specialties. Instructor: Clark. 3 units.

308. Philosophy and Theology After Wittgenstein. Follow-up to Theology of Wittgenstein course to see various ways his work has influenced philosophers and theologians, including Anscombe, Edwards, Diamond, Preller, Burrell, Ernst, McCahe, Kerr, R. Williams, and McClendon. Instructor: Hauerwas. 3 units.

309. Hermeneutics. Consideration of the nature of understanding and of several interpretive methods—such as phenomenological, existential, historical, literary, structural—along with their application to New Testament texts, primarily the parables of Jesus. Instructor: Hays. 3 units.

310. Readings in Judaica. Selected studies in Jewish material culture and problems in Jewish religious and intellectual history. Instructor: Bland, E. Meyers, and staff. 3 units.

314. Early Christianity in its Relation to Judaism. Examination and critique of influential studies of early church in its relation to Jews and Jewish Christians, beginning with work of F.C. Baur. Explorations of the relevance of these works for current discussions about "parting of the ways" between Judaism and Christianity and unity and diversity within ancient Judaism and early Christianity. Particular attention paid to the way in which the authors handle the primary sources and factors shaping their exegesis. Prerequisites: doctoral status or permission of instructor, contingent upon substantial course work in early Christianity and reading knowledge of Hebrew, Greek, German, and French. Instructor: Marcus. 3 units.

31A. The Life of Paul. A detailed critical reconstruction of Paul's biography, including his chronology, movements, and sociological locations(s), in order to provide the appropriate backdrop for the exegesis of his letters. Prerequisites: doctoral students or permission of instructor. Instructor: Campbell. 3 units.


323. Ethnography of Religion. Examines emergence of ethnography as major research methodology in study of religion. Considers how anthropology has historically constructed a "religious" subject and how contemporary ethnographic theory and praxis are articulated by postcolonial and postmodern critiques representation. Includes proto-ethnographic accounts of
contextualized and illuminated. Instructor: Chapman. 3 units.

368. Spacées, Bodies, & Narratives: Mapping Religion in Colonial India. How imperial cartography, understood as the mapping of territories, human bodies, cultural practices, and oral traditions, influenced mapping of religion in colonial India. Political and personal contexts of British and Indian-authored ethnographies, folklore collections, colonial census reports, and their impact on anthropological imagining of religion in South Asia. Instructor: Prasad. 3 units. C-L: History 345A

369. Early Jewish Apocalypses: Daniel and 1 Enoch. Examines earliest Jewish historical apocalypses, including Daniel, Apocalypse of Weeks, and Animal Apocalypse/Book of Dreams of 1 Epoch. Apocalypses will be situated within religious, social, and historical contexts of Antiochian persecution and Maccabean revolt and studied as literature of resistance. Primary texts studied in their original languages as well as ancient and modern translations. Instructor: Portier-Young. 3 units.

391. Special Readings in Religion. Readings vary from semester to semester. Consent of instructor required. Instructor: Staff. 3 units.

396. Teaching in Religion. Course specifically designed for students in Graduate Program in Religion. Offers students chance to engage with different faculty members on methods and strategies concerning classroom teaching. Students will be asked to reflect on their own classroom experience and student evaluations of their teaching. Pass/fail only. Consent of instructor required. Instructor: Staff. 1 unit.

**Romance Studies**

Professor Longino, Chair, (205 Languages); Associate Professor Gabara, Director of Graduate Studies (205 Languages); Professors Bell, Dubois, Finucci, Greer, Hardt, Jameson, Jenson, Longino, Mignolo, and Moi; Associate Professors Dainotto, Gabara, Rosa, Sieburth, Solterer, and Viego; Assistant Professors Adrián, Eisner, and Milian; Research Professor Dorfman; Professor of the Practice and Director of the French Language Program Tufts; Associate Professor of the Practice and Coordinator of the Portuguese Language Program Damasceno; Assistant Professor of the Practice and Director of the Italian Language Program Fellin; Assistant Professor of the Practice and Director of the Spanish Language Program Paredes

The Department of Romance Studies offers graduate work leading to the PhD in French/Francophone Studies, Spanish/Latin American Studies, and Italian Studies; it also offers a new PhD track in Romance Studies. Related work is required in any one or two of a number of other subject areas. A reading knowledge of one foreign language that is outside the major language is required. (For those following the Romance Studies track, proficiency in two or more languages is required.) In order to undertake graduate study in any of the Romance programs, the entering student should have credit for at least 18 semester hours (or equivalent) above the intermediate level in the major language.

**FRENCH (FRENCH)**

200S. Seminar in French Literature. Cross-cultural analysis of literary and cultural topics focusing on specific objects of inquiry. May be repeated. Instructor: Staff. 3 units.

206. Contemporary French Extreme Fiction. Contemporary innovations and new models of narration at beginning of the twenty-first century. May include the autoportrait (Leiris, Perec, Roubaud), the documentary (Bon, Kuperman, Bergougnioux, Houellebecq), and the minimalist school (Chevillard, Echenoz, Deville, Lenoir). Instructor: Staff. 3 units.

212. Structure of French. Modern French phonology, morphology and syntax. Pragmatic interpretation of the current modes of use, including language levels, situationism, and interrelations. Readings in current linguistic theory. Instructor: Staff. 3 units. C-L: Linguistics 221

240. Premodern Times: A User's Manual. Introduction to the earliest languages, literatures, and cultures in France and across Europe. Topics include orality and literacy, the experience of allegory, fictionality, the modern uses of the past. Major writers include the inventor of romance, Chrétien de Troyes, Provencal troubadours and trouvères,Guillaume de Machaut, the first professional writer, Christine de Pizan and Alain Chartier. Instructor: Solterer. 3 units. 3 units. C-L: Medieval and Renaissance Studies 240

247. Early Modern Studies. Pursuits of knowledge and the shaping of the individual. Literature of travel, science, sexuality, meditation, worldliness, theater, politics by well known and lesser known authors of seventeenth-century France. Genres may include fables, letters, memoirs, sermons, treatises, novels, plays. Instructor: Longino. 3 units. C-L: Medieval and Renaissance Studies 249

251. Topics in French Literature of the Eighteenth Century. Close study of a particular author, genre, or interpretive category of Enlightenment literature. Instructor: Staff. 3 units.

252. Topics in French Literature of the Modern Era. Close study of a particular author, genre, or interpretive category of the twentieth century. May include issues such as authorship, translation, reception or critical theory. Instructor: Staff. 3 units.

252S. Topics in French Literature of the Modern Era. Close study of a particular author, genre, or interpretive category of the twentieth century. May include issues such as authorship, translation, reception or critical theory. Instructor: Staff. 3 units.

256. Modern Literature and History. The interaction of history and literature in a particular period, for example: the occupation of France, the French Revolution. Problems of interpretation, historical memory, social identity, and narrative. Instructor: Staff. 3 units. C-L: History 256, International Comparative Studies 280B

261. French Symbolism. Poetry and literary theories of Baudelaire, Rimbaud, Mallarmé. Writings of Laforgue, Lautréamont,
Huysmans, Louys, and others as they define new aesthetic and ethical values in the framework of the Symbolist and the Decadent intellectual movements. Instructor: Staff. 3 units.

281. Paradigms of Modern Thought. An introduction to contemporary French philosophy and thought with a focus on identity and difference, truth and falsehood in enunciation, globalization and nationalism. Research work in French. Instructor: Staff. 3 units.

For Graduate Students Only

300. Graduate Reading Course. An intensive course in French to develop rapidly the ability to read French in several fields. Graduate students only. Instructor: Staff. 0 units.

306S. Teaching French at the Post-Secondary Level: Theories and Techniques. An overview of approaches to teaching French and of the theoretical notions underlying current trends. Focus is both theoretical and practical. Course objectives: (1) to investigate current issues in foreign language teaching and the relevance of linguistics and research in second language acquisition for language teaching; and (2) to guide the student as he/she develops techniques for effective classroom teaching, and learns to evaluate teaching performance and materials, and to develop good assessment tools and to valuate outcomes. Instructor: Tufts. 3 units.

315. Medieval and Modern Theatrical Culture. A comparative inquiry into the public rituals and spectacles in premodern France and the European world of theater in the twentieth century. Offers a chapter in the history of criticism: what is the part of medieval play in modernist aesthetics and politics. Medieval works will range from mystery, miracle, and carnival plays to royal ceremonies and legal trials. Modern works will include d'Annunzio, Artaud, Cocteau, Giraudoux, Sartre, Claudel, Fo. Instructor: Solterer. 3 units. 3 units.

325. Topics in Renaissance Prose. Rabelais, Marguerite de Navarre, Montaigne, and others. Instructor: Staff. 3 units.

326. Topics in Renaissance Poetry. Instructor: Staff. 3 units.

347. Topics in Seventeenth-Century French Literature. Includes genres, authors, movements, and works. Instructor: Longino. 3 units.

348. The Enduring Classic. Studies of the influence of the French classics over time and their function in the formation of French collective identity. Instructor: Longino. 3 units.

349. The Epistolary Genre. Fundamental questions of referentiality, materiality, and communication in writing. The first half is theoretical; the second explores issues raised through a selection of readings across time. Attention to gender and genre considerations. Instructor: Longino. 3 units.

351. Literature of the Eighteenth Century. Problems of literary history, critical reading, and interpretation, focused on varying topics. Instructor: Staff. 3 units.

352. Literature of the Eighteenth Century. Problems of literary history, critical reading, and interpretation, focused on varying topics. Instructor: Staff. 3 units.

355. Romantic Literature and French Culture and Politics. A study of French literature in the context of postrevolutionary society and culture. Readings might include nineteenth-century poetry (Hugo, Desbordes-Valmore), theater (Musset), political or philosophical prose, and historical discourse as well as contemporary critical and historical analyses of the period. Instructor: Staff. 3 units.

356. Topics in Nineteenth-Century French Literature. Includes genres, authors, movements, and works. Instructor: Bell or Jameson. 3 units.

366. Topics in Twentieth-Century French Literature. Includes genres, authors, movements, and works. Instructor: Moi. 3 units.


368. Structuralism. Introduction to the history of an intellectual movement from Ferdinand de Saussure to Roland Barthes, Claude Levi-Strauss, Jacques Lacan, and Michel Foucault. An emphasis is given to questions of method and issues concerning the individuation of cultures and individualities. Additional readings include chapters from Georges Canguilhem, Vincent Descombes, Jean Hyppolite, Alexandre Kojève, and Maurice Merleau-Ponty. Particular attention will be given to "non-Western" societies. Instructor: Mudimbe. 3 units. 3 units.

369. Culture and History in Twentieth-Century France. An interdisciplinary study of one relatively short historical period (the 1950s, the 1960s, the entre-deux guerres, etc.). The intellectual and cultural life of a period in its broader social, political, and historical context. Instructor: Moi. 3 units.

370. Topics in French and Francophone Literature. Concentration on twentieth-century literature. Historical and theoretical approach. Varying topics such as Regionalism, Nationalism and Postcolonialism; the status of fiction in a totalitarian space; Transtextuality and Francophone Literature. Readings include literary and nonliterary texts by writers such as Aquin, Chamoiseau, Confi ant, Chauvet, Faye, De Certeau, Depestre, Miron. Instructor: Staff. 3 units.

371. Topics in Migration, Literature, Transnational Writers, and Postnational Literature. A study of contemporary
productions of immigrant writers in Canada and France, exploring theoretical and sociological issues on citizenship, migration, transnational writers, and postnational literature. Readings might include literary and nonliterary texts by, among others: Ben Jelloun, Bouraoui, Charles, Huston, Kristeva, Robin, Sebbar, and Zumthor. Instructor: Staff. 3 units.

381. Special Topics Tutorial. Directed reading and research in areas unrepresented by regular course offerings. Instructor: Staff. 3 units.

391. French Seminar. Topics to be announced. Instructor: Graduate faculty. 3 units.

392. French Seminar. Topics to be announced. Instructor: Graduate faculty. 3 units.

ITALIAN (ITALIAN)

200. Topics in Italian Literature and Culture Abroad. Topics to be announced. Offered to students enrolled in Duke Study Abroad in Italy. Instructor: Staff. 3 units.

201S. Italian Linguistics. An interdisciplinary study of selected topics, such as history of linguistic theories, language and world view, semiotics, ethnonlinguistics, language and cinema, language and identity, discourse and conversation analysis. Taught in English. Instructor: Fellin. 3 units.

201SP. Italian Linguistics -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 201S. Further information available from instructor: Instructor: Fellin. 0 units.

202S. Topics in Italian Studies. Specific aspects of Italian history, civilization, culture, and institutions. Topics may vary. Taught in English. Instructor: Dainotto. 3 units. C-L: Literature 284S

202SP. Topics in Italian Studies -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 202S. Further information available from instructor: Instructor: Dainotto, Eisner, Finucci, Hardt. 0 units.

205S. Dante Studies. Focus on a particular aspect of Dante's work. Taught in English. Instructor: Eisner. 3 units. C-L: Medieval and Renaissance Studies 205S

205SP. Dante Studies -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 205S. Further information available from instructor: Instructor: Eisner. 0 units.

210S. Renaissance Studies. Focus on a particular aspect of the Italian or European Renaissance. Taught in English. Instructor: Finucci. 3 units. C-L: Medieval and Renaissance Studies 210S, Art History 210S

210SP. Topics in Renaissance Studies -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 210S. Further information available from instructor. Instructor: Finucci. 0 units.

220S. Topics in Sexuality and Gender Studies. The study of identity and difference and the representation of bodies, genders, and desires through developments in medicine and anatomy. May include different historical periods. Readings from public to private documents, literary texts, playscripts, medical treatises, and pamphlets. Taught in English. Instructor: Finucci and staff. 3 units. 3 units. C-L: Women's Studies 219S

220SP. Topics in Sexuality and Gender Studies -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 220S. Further information available from instructor. Instructor: Finucci and staff. 0 units.

221S. Literary Guide to Italy. A journey of Italy through literary, cinematic, and musical texts through Italy's sights and customs, as well as the place of Italy, both the real and imagined, in the aesthetics of the Grand Tour. Taught in English. Instructor: Dainotto. 3 units. C-L: Literature 280S, German 221S

221SP. Literary Guide to Italy -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 221S. Further information available from instructor. Instructor: Dainotto. 0 units.

225S. Cinema and Literature in Italy. A study of the relation between literature and film in Italy. Topics include: cinematic versions of novels, influence of literature and literary figures on the construction of an Italian cinematic imagination, effects of cinema on literature, women's fiction and the woman's picture, neorealism. Taught in English. Not open to students who have taken this course as Italian 170S. Instructor: Dainotto, Finucci, or Hardt. 3 units. C-L: International Comparative Studies 281ES

225SP. Cinema and Literature in Italy -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 225S. Further information available from instructor. Instructor: Dainotto, Finucci, or Hardt. 0 units.

230S. Antonio Gramsci and the Marxist Legacy. Gramsci's reinterpretation of Marxism in the context of fascist Italy. The uses of Gramsci's key concepts--subaltern, hegemony, dominance, popular culture, Americanism, Southern question--in other cultural/historical contexts, such as Indian subaltern historiography, British cultural studies or American literary studies. Taught in English. Instructor: Dainotto. 3 units. C-L: Literature 284S

230SP. Antonio Gramsci -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 230S. Further information available from instructor. Instructor: Dainotto. 0 units.

240. Seminar in Medieval and Renaissance Studies. The study and interpretation of medieval and Renaissance culture. Instructor: Finucci. 3 units.

381. Special Topics Tutorial. Directed reading and research in areas unrepresented by regular course offerings. Instructor: Staff. 3 units.
PORTUGUESE (PORTUGUE)
202S. Topics in Lusophone Literature and Culture. Exploration of topics of cultural formation in the Portuguese-speaking world that emphasize autochthonous cultural theory. Examples include: Brazilian popular culture, Literatures of Resistance, Lusophone Africa and Independence, Portugal Post-Salazar. A graduate-level course open to juniors and seniors. Level of Portuguese required varies with semester topic; students should consult instructor. Prerequisite: 100-level Portuguese course or consent of instructor. Instructors: Damasceno and staff. 3 units.

248S. Transatlantic Cultures: Narratives of Discovery, Empire, Decolonization, and Europeanization. Explores, through literature, film, and theoretical readings, basic themes of Portuguese culture. Focuses on narratives of discovery, empire, decolonization, the admixture of cultures, and concerns of contemporary Portugal within the European Union. Questions of Portuguese identity during the epoch of discovery and expansion; the Portuguese presence in Asia, Africa, and Brazil; the role of postcolonial Portugal and Lusophone culture within the European context. Taught in Portuguese, translations of readings available. Prerequisite: 100-level Portuguese course or consent of instructor. Instructors: Damasceno and staff. 3 units.

392S. Contemporary Brazilian Culture and Society. Core course for Duke in Brazil. Taught in English. Introductory course on major aspects of Brazil and Brazilian history; race, religion, culture, social movements, film, theatre and visual arts. Course option for students to receive graduate credit for work done in Duke in Brazil. Students will be expected to attend class and complete assignments for PTG 140S and complete a complementary individual research project at the graduate level. Taught in Rio de Janeiro. Instructor: Damasceno and Staff. 3 units.

ROMANCE STUDIES (ROMST)
200S. Seminar in Romance Studies. Topics to be announced. Instructor: Staff. 3 units.
201S. Methods and Theories of Romance Studies. Provides students in any PhD track of the department of Romance Studies with fundamental training in both general literary theory and in the specific methods of romance criticism. Instructor: Staff. 3 units. C-L: Literature 251S
250S. Issues in Second Language Acquisition. Advanced applied linguistics course examining different areas of interests in the field of second language acquisition (SLA). Overview of main research areas in the field. Topics include: Language Testing, Action Research in SLA, Communicative Language Teaching, the role of classroom instruction in SLA, or the relationship between SLA research and foreign language learning. Students expected to become conversant with the research literature in the area and the different methodologies used in SLA research, carry out a classroom-based quantitative and/or qualitative research project, and produce a research paper that might be submitted to relevant conferences. Topics vary each year. Consent of instructor required. Instructor: Staff. 3 units.
306. Theories and Techniques of Teaching Foreign Languages. A survey of approaches to foreign language teaching, an introduction to the theoretical notions underlying current trends, and a language-specific practicum. Instructor: Tufts. 3 units.
310. Critical Frameworks. An introduction to critical theory through a series of interconnected readings organized around a major theoretical approach or issue. Topics may vary. Instructor: Staff. 3 units.
320. Topics in Romance Studies. A cycle of seminars that explores a theoretical problem cross-culturally through two or more Romance traditions: French and Francophone, Italian, Portuguese and Luso-Brazilian, Spanish and Latin American. Instructor: Staff. 3 units.

SPANISH (SPANISH)
200S. Seminar in Spanish Literature. Topics to be announced. Instructor: Staff. 3 units.
212S. Topics in Spanish Linguistics. In-depth analysis of one area of Spanish linguistics. Topics may include Spanish phonology, Spanish syntax, discourse analysis, applied linguistics, or Spanish pragmatics. Small research projects with a hands-on approach required. Instructor: Staff. 3 units. C-L: Linguistics 212S
260. Paradigms of Modern Thoughts. Exploration of modern thought in Latin America. Theories in the social sciences relevant for the humanities (for example, dependency theory, internal colonialism, subaltern studies) will be compared with cultural theories mainly expressed in essays and literature in general and with philosophical thinking grounded in Latin American colonial and postcolonial histories. Instructor: Mignolo or staff. 3 units.
280. Emigrants and Immigrants: Spain in the Sixties and Now. A study of the cultural processes generated by two significant migratory movements in Spain: one in Catalonia in the 1960s and early 1970s, composed mostly of impoverished peasants coming from southern Spain; and the more recent global wave composed of Latin American, African, and Filipino immigrants to the affluent post-industrial areas. The seminar will use literary and cinematic texts, and testimonial narratives. Instructor: Staff. 3 units.

For Graduate Students Only
306S. Teaching Spanish as a Foreign Language. Study of language learning and teaching from theoretical and practical points of view. Examines principles and practices of teaching a second or foreign language with concentration on recent
interactive and communicative models of foreign language instruction. Goals include introducing principles of second language acquisition and learning; critically reading relevant literature in the area(s); and contributing to foreign language teacher education through reflective and critical thinking. Readings and discussions supplemented by classroom observation and evaluation. Graduate students only. Instructor: Paredes. 3 units.

341. Indigenous Chronicles of the Colonial Period. Exploration of the relationships between languages, writing, memories, and political practices by focusing on indigenous writers such as Guaman Poman de Ayala, Alvarado Tezozomoc, Pachacuti Yamki, Alva Ixtlilxochitl. Spanish and Portuguese writers will also be included as well as anonymous texts (for example, Huarochni Manuscripts, Popol Vuh, and Mesoamerican Codices). Instructor: Mignolo. 3 units.

344. Philosophy, Cultural History, and Literature in Latin America. Special topics. Instructor: Mignolo. 3 units.

345. Contested Spaces: Writing in Nineteenth-Century Latin America. Questioning teleological constructions of "Literature," "national literature," and the like, this course studies literary, nonfictional, and pictorial representational practices in nineteenth-century Spanish America and Brazil in their institutional and political setting. Instructor: Staff. 3 units.

346. Modern Spanish-American Fiction. Study of interaction between literature and visual culture during the twentieth century. Specific topics may focus on movements such as the avant-garde and concretismo, or concepts such as the neo-baroque and interdisciplinary fictions. Instructor: Gabara. 3 units.

351. Narrative Forms of Early Modern Spain. Specific topics may focus on one or more forms, including novels of chivalry; sentimental, Moorish, or pastoral novels; hagiography and the mystics; the novella form, picaresque fictions, and the baroque and interdisciplinary fictions. Instructor: Gabara. 3 units.

353. Cervantes. The life and works of Cervantes, with emphasis on the Quijote, the Novelas ejemplares and Persiles y Segismunda. Instructor: Greer. 3 units.

354. Drama of Renaissance and Early Modern Spain. Study of the nature, development, and cultural function of drama in sixteenth- and seventeenth-century Spain through representative plays-canonical and noncanonical-of the period. Specific topics may include: early drama and its cultural locations; forms and theories of tragedy and comedy; women and subjectivity in Golden Age drama; critical perspectives on the comedias; historical and religious drama and protonational self-definition; or performance and the place of the stage as a cultural institution. Instructor: Greer. 3 units.

358. Spanish Lyric Poetry before 1700. Study of selected poetry of the Middle Ages, Renaissance, and baroque, with attention to such questions as the interaction of elite and popular culture in the evolution of poetic forms, the languages of love and faith, and the political uses of poetry. Instructor: Greer. 3 units.

360. Cross-cultural (Mis)Understanding: Europe and the New World, 1480-1800. Survey form or in-depth analysis of specific topics: the interrelations between Europe and the New World from the Renaissance to the Enlightenment, and from the last decades of the Inca and Aztec Empires to the wars of independence. The "clash of civilizations" and its implications for the cultural history of the early modern period and for the colonial expansion of the west. Instructor: Mignolo. 3 units.

365. Thinking Independence: From Tupac Amaru to 1898. Study of the cultural problems surrounding the Latin American wars of independence, and the pre- and post-independence periods. May focus on foundational fictions, political writings, the so-called Romantic period. Instructor: Staff. 3 units.

366. Nineteenth-Century Prose Fiction. Readings by novelists such as Valera, Galdós, Alas, and Pardo Bazán in the light of current critical theory. Instructor: Sieburth. 3 units.

367. The City, Modernity, Gender, and Literature: Nineteenth-Century Madrid. The course will examine the intersections among four terms: the city, modernity, gender, and literature. We will focus on 19th-century Madrid. We will explore the following topics: the concept of the public sphere and its contradictions; the gendering of public and private spheres and of the experience of modernity; the problem of representation in , and of, the city; mass culture and the city; the realist novel and women in the streets. Instructor: Staff. 3 units.

370. Spanish Texts of the Post-Dictatorship: La Movida en La Transicion, 1973-1993. An analysis of the political and cultural processes at play during the Spanish transitional period when, with the 1973 assassination of Almirante Carrero Blanco and the subsequent death of general Franco in 1975, the country transformed the autocratic and military state imposed by Franco's dictatorship into the current democratic state. Focus on literary and cinematic texts and of the period, drag culture, pop music, and comics. Instructor: Staff. 3 units.

371. Cultural History and Theory. Seminar covering various topics in Latin American cultural history and theoretical production such as: (a) colonial legacies and postcolonial theories; (b) the construction of identities and the critique of cultural colonialism; (c) contemporary critical production in Latin America, from dependency theory to transnationalism and postmodernity. May be repeated for credit. Instructor: Mignolo or staff. 3 units.

372. Latin American Vanguard. A seminar on the major avant-garde movements between 1915 and 1940, based in an interdisciplinary study of literature and visual culture. Examines contemporary criticism as well as theoretical texts from the period. Topics include: critical nationalism, indigenism vs. primitivism, formalism and political art, the "gender of modernity." Instructor: Gabara. 3 units.

375. Hispanic Literature, Mass Culture, and Theory. A study of Hispanic texts thematizing the effects of mass cultural
fictions (serial novels, radio songs, movies) on those who consume them. Fictional works will be juxtaposed with theories on the effects of mass culture and its relationship to canonical literature. Authors of fictional texts include Cervantes, Galdós, Martí, Borges, Marsé, Puig, and Martín-Gaite. Instructor: Sieburth. 3 units.

381. Special Topics Tutorial. Directed reading and research in areas unrepresented by regular course offerings. Instructor: Staff. 3 units.

391. Hispanic Seminar. Each semester one of the following topics will be selected for intensive treatment: the Spanish language in America, studies in medieval literature, studies in the literature of the Golden Age, studies in Latin American literature, studies in the Spanish Renaissance and baroque, studies in Spanish poetry, studies in nineteenth-century Spanish literature, and studies in twentieth-century literature. Instructor: Staff. 3 units.

392. Hispanic Seminar. Each semester one of the following topics will be selected for intensive treatment: the Spanish language in America, studies in medieval literature, studies in the literature of the Golden Age, studies in Latin American literature, studies in the Spanish Renaissance and baroque, studies in Spanish poetry, studies in nineteenth-century Spanish literature, and studies in twentieth-century literature. Instructor: Staff. 3 units.

Slavic, Eurasian, and East European Studies

Edna Andrews, PhD, Director

A certificate is available in this program.

Since its establishment in 1991, the Center for Slavic, Eurasian, and East European Studies has brought together faculty and students from different departments and schools within Duke University who share a common interest in this region. The Center sponsors a variety of visiting speakers, workshops, conferences, and other programs to promote research and the dissemination of knowledge about the former Soviet Union and Central and Eastern Europe.

The Center offers a certificate in Slavic, Eurasian, and East European studies to students enrolled in the Duke Graduate School, the Nicholas School of the Environment and Earth Sciences, the Law School, the Fuqua School of Business, or the Medical School. The certificate program requires that participating Duke graduate students pursue coursework related to this region in language, literature, economics, history, political science, public policy, law, or business. A student receiving the certificate will have completed significant cross-disciplinary coursework in this area and demonstrated a mastery of at least one related Slavic language.

The Center also offers a certificate in Slavic, Eurasian, and East European studies with a concentration in Russian and East European legal studies. This certificate, inaugurated in 1996, is the first of its kind offered by an American university.

Students seeking either certificate must complete five courses drawn from three different disciplines. Two of the five courses must be from a single discipline, excluding the student’s major department. A sixth course of a topical nature will be offered as an interdisciplinary seminar on an annual basis and will require a major research paper of all certificate candidates. In order to receive either certificate, students will be expected to demonstrate language proficiency in a Slavic or Eastern European language at the intermediate level. Oral and written testing will be required to demonstrate the required level of proficiency.

The Center also awards a limited number of Foreign Language and Area Studies fellowships for graduate students.

Requirements:

Graduate School, Fuqua, MED, Law, and NSOE students are eligible after completion of:

• Five courses from three different disciplines, and an interdisciplinary course sponsored by the center (two of the five must be from a single discipline, excluding the student’s major).

• Demonstrated language proficiency in a Slavic or Eastern European language at the intermediate level.

Certificate with a specialization in legal studies may be received by graduate students with special interest in law/legal institutions in the former Soviet Union and Eastern:

• Must satisfy general requirements noted above, but with three of the five required courses drawn from a list specifically relevant to legal studies.

• Complete an interdisciplinary seminar and demonstrate language proficiency.

For further information about the Center and its programs, please contact the Center director, Professor Edna Andrews, Box 90260, Duke University, Durham, NC 27708-0260; or visit the Web site at http://www.duke.edu/web/CSEEES.

Slavic and Eurasian Studies

Professor Holmgren, Chair; Associate Professor Gheith, Director of Graduate Studies; Professor Andrews, Holmgren, Miller; Associate Professors Gheith and Tetel; Assistant Professors Goknar, Tuna; Professor of the Practice McAuliffe; Associate Professors of the Practice Flath, Makimova, Van Tutyl; Adjunct Professors Newcity and Zitser; Research Scholar Mickiewiez
The Department of Slavic and Eurasian Studies offers graduate work leading to the AM degree in Russian literature and culture, Slavic linguistics, and Slavic and Eurasian studies.

Beyond the strong commitment to improving and diversifying the language proficiency of its students and giving them solid training in research, the faculty of the department prepare students in a variety of adjacent fields, such as art history, cultural anthropology, cultural studies, film, gender studies, history, legal studies, linguistics, literary studies, political science, religion, theater studies, translation, and visual and informational studies. All entering students must demonstrate advanced knowledge of Russian or another Eurasian language. Reading knowledge of French, German, or another Eurasian language is also required. Requirements for the AM degree must be met by completion of coursework and by passing either A) a comprehensive exam, or B) an oral exam after the completion of a Master’s thesis. Coursework in Russian literature and culture must include seven courses selected from literature, film, or other culture courses offered by the Department of Slavic and Eurasian Studies; two courses offered in other humanities or social science departments at Duke; and one elective. Coursework in Slavic and Eurasian studies requires a minimum of six courses in Slavic and Eurasian cultures, with at least four focused on comparative Slavic and Eurasian or non-Russian Slavic or Eurasian topics. Students in Slavic linguistics must demonstrate competence in Russian and Slavic diachronic linguistics, and in general linguistic theory. Linguistic students must demonstrate knowledge of one Slavic language from the West and one from the South Slavic area, in addition to Russian. Required courses are at least four courses in Slavic linguistics (including Old Church Slavonic), one course in the history of the West Slavic languages, one course in the history of the South Slavic languages, at least two courses in general linguistics and semiotics, and one course in Russian literature. The AM program must be completed in four semesters or less.

While the Department of Slavic Languages and Literature has offered a doctoral program, that program is currently suspended and until further notice the University will not be considering applications for the PhD in Slavic and Eurasian Languages. Admission to the AM program is open.

Further information about the graduate programs, including specific requirements, can be obtained from the director of graduate studies.

RUSSIAN (RUSSIAN)


206. Russian Modernism. Russian culture between the 1890s and the 1920s, including visual, musical, literary arts, and developments ranging from Neo-Christian mysticism, cosmism, synthesis of the arts, and revolutionary activism. Focus on literary-philosophical thought of that period. Taught in English. Instructor: Mickiewicz. 3 units.

208. Stylistic and Compositional Elements of Scholarly Russian. Intensive study of Russian scholarly and scientific texts from a variety of disciplines, including biology, business, anthropology, economics, law, history, mathematics, physics, political sciences, sociology, psychology, linguistics, and literary criticism. Mastery of stylistic and discourse strategies. Analysis of cultural patterning in textual construction in the humanities, social and natural sciences. Taught in Russian. Prerequisite: Russian 64 or consent of instructor. Instructor: Maksimova. 3 units.

211. Legal and Business Russian. Analysis of Russian language and culture in the area of legal studies and conducting business in or with Russia and other Commonwealth of Independent States countries. Primary materials include legal codes, law journals, contracts, advertising, financial documents, redactions of the Soviet and Russian constitutions (1905-present). Specific attention given to the analysis of evolution of property and ownership legislation, the workings of the legislative, executive and judicial branches of the Russian Federation government and contrastive analysis of Soviet, Russian (and where relevant Western) systems of jurisprudence. Taught in Russian. Prerequisite: Russian 102S or equivalent. Instructor: Andrews or Maksimova. 3 units.

215. Theory and Methods of Comparative Linguistics. Diachronic and synchronic approaches to the study of comparative linguistics in phonology, morphology, morphophonemics, syntax, and lexical categories in the context of the world's languages. Both Indo-European and non-Indo-European languages. Topics include theories of reconstruction, languages in contact, abductive processes, questions of linguistic typology and cultural-based approaches to the analytical study of human languages. Research project required. Instructor: Andrews. 3 units.

218S. The Russian Intelligentsia and the Origins of the Revolution. 3 units. C-L: see History 201S

242S. Soviet Art after Stalin 1956-1991. Dissident art, graphic design, fine arts and architecture in context of Cold War and decline of totalitarianism. Themes include Soviet artists and the west, and representation of women in times of flux. Open to juniors and seniors and graduate students who must follow a more comprehensive reading program and complete upper level assignments. Instructor: Kachurin. 3 units. C-L: Art History 244

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245. Theory and Practice of Translation. Detailed study of the American, European, and Slavic scholarly literature on translation combined with close analysis of existing literary and journalistic translations and a program of practical translation exercises and projects from English to Russian and Russian to English. Prerequisite: three years of Russian language study or consent of instructor. Instructor: Staff. 3 units.

246. Media in Post-Communist Societies (B). 3 units. C-L: see Public Policy Studies 243; also C-L: Political Science 276

258. The Russian Novel. Close reading of Tolstoy's Anna Karenina, Dostoevsky's Possessed, Andrey Bely's Petersburg, Bulgakov's Master and Margarita, Nabokov's The Gift, and Makine's Memoirs of My Russian Summers. Discussions will focus on these representative writers' changing perceptions of, and responses to social and ethical issues and of creativity, itself, as the genre evolved in the modern times between the 1870s and now. Final research paper required and can include in-depth discussion of one of the works or the comparison of one or more aspects of several texts. Taught in English. Readings in Russian. Instructor: Mickiewicz. 3 units.

262. Masterpieces of Nineteenth-Century Russian Literature II. Selected authors, works, and genres from the second half of the nineteenth century. Authors include Turgenev, Chernyshevsky, Dostoevsky, Tolstoy, Saltykov-Shchedrin, and Chekhov. Taught in English. Readings in Russian. Instructor: Van Tuyl. 3 units.

263. Art & Dissidence: Films of Tarkovsky, Kubrick, Kurosawa, & Lynch. 3 units. C-L: Art History 263

269. Women and Russian Literature. Issues of gender and society in women's writing in Russian from the eighteenth to the twentieth centuries. Both autobiographical writings and prose fiction. Discussions of whether Russian women's writings constitute a tradition and what role these works have played in Russian literature and culture. Taught in English. Readings in Russian. Instructor: Gheith. 3 units.

271S. Bunin: Mystery of the Russian Soul and Metaphysical Memory. Same as Russian 171S, but includes additional assignments. Taught in Russian. Readings in Russian. Intensive critical component. Instructor: Maksimova. 3 units.

275. Tolstoy. Introduction to life, works, and criticism, including Tolstoy's philosophical and ethical discourse. Readings include: War and Peace, Anna Karenina, the shorter fiction, dramatic works and essays. Taught in English. Readings in Russian. Instructor: Van Tuyl. 3 units.


277S. Chekhov. Drama and prose works. Readings in Russian. Instructor: Flath. 3 units.

286S. Zamyatin. The novel We, short fiction, plays, and critical essays. In-depth textual analysis and study of Russian, American, and European criticism on Zamyatin, including his role in science fiction and anti-utopian literature in Russia and the West. Readings in Russian and English. Final research project required. Instructor: Andrews or Maksimova. 3 units.


297. Russian Poetry. Focus on nineteenth and twentieth centuries, including the Golden Age and the Silver Age. Authors include Pushkin, Lermontov, Bely, Blok, Akhmatova, Tsseteava, Mandelshtam, Pasternak, and Mayakovsky. Taught in English or Russian, according to students' Russian language proficiency. Russian texts. Instructor: Van Tuyl. 3 units.

299S. Special Topics. Seminars in advanced topics, designed for seniors and graduate students. Instructor: Staff. 3 units.

For Graduate Students Only

301. Elementary Russian. Introduction to understanding, speaking, reading, and writing. Audiolingual techniques are combined with required recording-listening practice in the language laboratory. Instructor: Staff. 3 units.

302. Elementary Russian. Introduction to understanding, speaking, reading, and writing. Audiolingual techniques are combined with required recording-listening practice in the language laboratory. Instructor: Staff. 3 units.

303. Intermediate Russian. Intensive classroom and laboratory practice in spoken and written patterns. Reading in contemporary literature. Prerequisite: Russian 301, 302 or consent of instructor. Instructor: Staff. 3 units.

304. Intermediate Russian. Intensive classroom and laboratory practice in spoken and written patterns. Reading in contemporary literature. Prerequisite: Russian 301, 302 or consent of instructor. Instructor: Staff. 3 units.

305. Advanced Russian Conversation and Readings. Nineteenth- and twentieth-century literature in the original. Conducted in Russian. Prerequisite: Russian 303, 304 or consent of instructor. Instructor: Staff. 3 units.

Conducted in Russian. Prerequisite: Russian 303, 304 or consent of instructor. Instructor: Staff. 3 units.

**307. Advanced Russian.** Advanced grammar review with an emphasis on the refinement of oral and written language skills. Development of writing style through compositions and essays. Prerequisite: Russian 306 or consent of instructor. Instructor: Andrews. 3 units.

**308. Advanced Russian: Readings, Translation, and Syntax.** Intensive reading and conversation with emphasis on contemporary Russian literary and Soviet press texts. English-Russian translation stressed. Russian media, including television and films. Prerequisite: Russian 307 or consent of instructor. Instructor: Andrews. 3 units.

**309. Russian Stylistics and Conversation.** Refinement of stylistic control and range in spoken and written Russian. Emphasis on fluent discursive skills, as well as development of expository prose style. Prerequisite: Russian 307 and 308, or consent of instructor. Instructor: Maksimova. 3 units.

**310. Russian Stylistics and Conversation.** Refinement of stylistic control and range in spoken and written Russian. Emphasis on fluent discursive skills, as well as development of expository prose style. Prerequisite: Russian 307 and 308, or consent of instructor. Instructor: Maksimova. 3 units.

**311S. Advanced Russian Language and Culture.** Advanced grammar review with additional emphasis on phonetics and conversation. Culture component includes literature, films, museums, and theater performances. (Taught in St. Petersburg in Russian.) Prerequisite: Russian 306 or equivalent. Instructor: Staff. 3 units.

**312S. Advanced Russian Language and Culture.** Advanced grammar review with additional emphasis on phonetics and conversation. Culture component includes literature, films, museums, and theater performances. (Taught in St. Petersburg in Russian.) Prerequisite: Russian 306 or equivalent. Instructor: Staff. 3 units.

**335. Contemporary Russian Media.** Analytical readings and study of change and development in all the primary forms of former Soviet mass media from 1985 to the present (newspapers, journals, and television). Topics include censorship, TASS, samizdat. Taught in English. Readings in Russian. Prerequisite: Russian 64 or equivalent. Instructor: Andrews. 3 units.


**351. Topics in Teaching Methodology.** Application of linguistic principles in the classroom. No prior knowledge of linguistics required. Instructor: Staff. 2 units.

**399. Special Readings.** Advanced readings in nineteenth- and twentieth-century Russian literature in the original. Instructor: Staff. 3 units.

**BALTO-FINNIC (BALTFIN)**

**301. Elementary Estonian.** Introduction to understanding, speaking, reading, and writing Estonian. No preliminary knowledge of Estonian necessary. Instructor: Staff. 3 units.

**302. Elementary Estonian.** Introduction to understanding, speaking, reading, and writing Estonian. No preliminary knowledge of Estonian necessary. Instructor: Staff. 3 units.

**303. Intermediate Estonian.** Intermediate classroom and laboratory practice in spoken and written patterns. Readings in traditional literature. Prerequisites: Polish 1 and 2, or consent of instructor. Instructor: Staff. 3 units.

**304. Intermediate Estonian.** Intermediate classroom and laboratory practice in spoken and written patterns. Readings in traditional literature. Prerequisites: Polish 1 and 2, or consent of instructor. Instructor: Staff. 3 units.

**POLISH (POLISH)**

**301. Elementary Polish.** Introduction to understanding, speaking, reading, and writing in Polish. No preliminary knowledge of Polish necessary. Instructor: Staff. 3 units.

**302. Elementary Polish.** Introduction to understanding, speaking, reading, and writing in Polish. No preliminary knowledge of Polish necessary. Instructor: Staff. 3 units.

**303. Intermediate Polish.** Intensive classroom and laboratory practice in spoken and written patterns. Readings in contemporary literature. Prerequisites: Polish 1 and 2, or consent of instructor. Instructor: Staff. 3 units.

**304. Intermediate Polish.** Intensive classroom and laboratory practice in spoken and written patterns. Readings in contemporary literature. Prerequisites: Polish 1 and 2, or consent of instructor. Instructor: Staff. 3 units.

**SERBIAN AND CROATIAN (SERBCRO)**

**301. Elementary Croatian and Serbian.** Introduction to understanding, speaking, reading, and writing Croatian and Serbian. No preliminary knowledge of Croatian and Serbian necessary. Instructor: Andrews. 3 units.

**302. Elementary Croatian and Serbian.** Introduction to understanding, speaking, reading, and writing Croatian and Serbian. No preliminary knowledge of Croatian and Serbian necessary. Instructor: Andrews. 3 units.

**TURKISH (TURKISH)**

**220S. The City of Two Continents: Istanbul in Literature and Film.** Presents Istanbul, a city located in both Europe and Asia, as a site of political identities in conflict. Overview of contemporary literature and film set in Istanbul. Studies ethical
implications of textual and visual representations of various people and groups interacting in urban spaces. Addresses the reasons for Turkey's love-hate relationship with the Ottoman past and Europe. Historical background, modernity, identity, Islam, and cosmopolitanism. Open to graduate students who must follow a comprehensive reading program and complete graduate-level assignments. Knowledge of Turkish not required. Instructor: Göknar. 3 units.

235. The Turks: From Ottoman Empire to European Union. Reading and assessment of new scholarship on Ottoman culture, society, politics, and state. Supplemented by critical texts on historiography, identity, gender, religion, and orientalism. Topics include "gazi thesis," secular and Islamic law, "Kadi justice," everyday life, and role of women. Final research project with interdisciplinary focus. Instructor: Göknar. 3 units.

245. Orhan Pamuk and World Literature. Studies the novels and non-fiction of Nobel Laureate Orhan Pamuk as an introduction into ethics and politics of World Literature. Addresses social consequences of Pamuk's role as an intellectual-author who mediates between the national tradition and an international canon. Political implications of Sufism, cultural revolution, Orientalism, and post-colonialism. Secondary focus on cosmopolitan Islam and the Ottoman Empire. Open to graduate students who must follow a comprehensive reading program and complete graduate-level assignments. No prerequisites; taught in English. Instructor: Gök­nar. 3 units.

UKRAINIAN (UKRAIN)

301. Elementary Ukrainian. Introduction to understanding, speaking, reading, and writing Ukrainian. No preliminary knowledge of Ukrainian necessary. Instructor: Staff. 3 units.

302. Elementary Ukrainian. Introduction to understanding, speaking, reading, and writing Ukrainian. No preliminary knowledge of Ukrainian necessary. Instructor: Staff. 3 units.

Sociology

Professor Spenner, Chair (268 Sociology-Psychology); Associate Professor Moody, Director of Graduate Studies (332 Sociology-Psychology); Professors Bonilla-Silva, Burton, Chaves, Gao, George, Gereffi, James (public policy), Keister, Land, Lin, McPherson, Morgan, O’Rand, Smith-Lovin, Spenner, and Yi (Center for Study of Aging and Human Development and Geriatric Division, Department of Medicine, Medical School); Associate Professors Baker (cultural anthropology), Brady, Cric­hlow (African and African-American studies), Gold (psychiatry), Frankenberg (public policy), Healy, Merli (public policy), Moody, and Read; Assistant Professor Gibson-Davis (public policy); Professors Emeriti Maddox, Simpson, Smith, Tiryakian, and Wilson; Research Profess­ors Blankenh­uis (Global Health Institute), Stallard (Center for Population and Aging), and Yashin (Center for Population and Aging)

The departments offers graduate work leading to the MA and PhD degrees in sociology.

Entering graduate students should already have completed a minimum of 12 semester hours in sociology and an additional 12 semester hours in related work (e.g., other social sciences, statistics, computer science, philosophy, mathematics). Accepted applicants who have not had such preparation may be required to take work beyond the usual requirements. Applicants for admission are required to take the verbal and quantitative aptitude tests of the Graduate Record Examination.

The PhD program requires the student to take six core courses. In addition, the student is to take three year-long professionalization seminars (Sociology 301, 302, 303) for the exposure of frontier research issues and professional activities in sociology. The core courses include: Sociological Theory (206), Social Statistics I and II (Sociology 212, Sociology 213), Research Methods (Sociology 217S or equivalent), and two out of three advanced methods courses (such as Sociology 208, Sociology 214, Sociology 215). Preliminary exam specializations include population studies, comparative and historical sociology, economic sociology, medical sociology, stratification, social psychology, networks, religion, and race. A student entering with only an undergraduate degree and adequate course preparation would need to take seventeen courses to satisfy degree requirements. Up to three courses may be transferred for graduate work taken elsewhere.

Further details concerning the general departmental program, the specialties and their requirements, departmental facilities, the faculty, ongoing research, and stipends available may be obtained from the director of graduate studies.

Sociology Courses (SOCIOL)

202S. Understanding Ethical Crisis in Organizations. 3 units. C-L: see Study of Ethics 202S; also C-L: Political Science 225S, Public Policy Studies 203S

206. Sociological Theory. Structure, foundations, and historical antecedents of recent formulations of such theoretical approaches as phenomenological sociology, exchange theory, critical theory, structuralism, neo-Marxist sociology, sociobiology, and action theory. Instructor: Bonilla-Silva, Healy, or Moody. 3 units.

208. Survey Research Methods. Theory and application of survey research techniques in the social sciences. Sampling, measurement, questionnaire construction and distribution, pretesting and posttesting, response effects, validity and reliability, scaling of data, data reduction and analysis. Instructor: Brady, Lin, or staff. 3 units.

211S. Proseminar in Sociological Theory. Selected topics in the development of sociological thought; systematic sociological theory; interrelations with other social and behavioral sciences. Background of sociology; formal aspects of theory:
sociology of knowledge, evolutionary theory, sociobiology, and sociological theory. Instructor: Bonilla-Silva, Healy, or Moody. 3 units.


213. Social Statistics II: Discrete Multivariate Models. Assumptions, estimation, testing, and parameter interpretation for the log-linear, logit, logistic, and probit models. Model comparisons; applications of statistical computing packages and programs. Prerequisite: Sociology 212 or equivalent. Instructor: Land or McPherson. 3 units.


216S. Advanced Methods of Demographic Analysis. Mathematical methods and computer software for the analysis of population dynamics. Life table and stationary population theory; methods of life table estimation; multiple-decrement and multistate life tables; stationary population theory and its extensions; model life tables and stationary populations; two-sex models and interacting populations; hazard regression models, grade-of-membership analysis, and cohort studies. Instructor: Land or Stallard. 3 units.

217S. Proseminar in Social Statistics and Research Methods. Selected topics in the collection and analysis of social science data. Discrete and continuous models of measurement, hazards models, event history analysis, and panel data, dynamic models and time series analysis, research design, evaluation research methods, and social statistics and research methods. Instructor: Land, Lin, McPherson, or Moody. 3 units.

222S. Proseminar in Comparative and Historical Sociology. Selected topics in the differentiation and transformation of societies: theories of social change; globalization and comparative development; societal transformations and social institutions; culture, values, and ideas; social movements and political sociology; comparative social policies; comparative and historical sociology. Instructor: Bonilla-Silva, Brady, Gao, or Lin. 3 units.

223S. Proseminar in Crime, Law, and Deviance. Selected topics in crime and the institutions of social control: theories of crime causation; human development and criminal careers; social control and the criminal justice system; sociology of law; crime, law, and deviance. Instructor: Land. 3 units.

224S. Proseminar in Population Studies. Selected topics: population dynamics; mortality, morbidity, and epidemiology; urbanization and migration; demography of the labor force; demography of aging; population studies. Instructor: Land, Moody, Morgan, or R'Orand. 3 units.

225S. Proseminar in Economic Sociology. Selected topics: basic concepts, theories, and methods; organizations and institutions; social networks and social capital; globalization and markets; occupations and work. Instructor: Brady, Gao, Gereffi, Lin, Keister, Merkx, or Spenner. 3 units.

226S. Proseminars in Social Institutions and Processes. Selected topics in the sociology of institutions and social and institutional behavior: social networks; political sociology; sociology of religion; sociology of science; sociology of education. Instructor: Healy, Moody, or staff. 3 units.

227S. Proseminar in Medical Sociology. Selected topics in medical sociology: social structure and health; social behavior and health; organization and financing of health care; medical sociology (for example, social epidemiology, stress and coping, health and aging). Instructor: Burton, George, Gold, Lin, or Moody. 3 units.

228S. Social Stratification. Core and special topics in social stratification, including explanations for the existence, amount, and various dimensions of stratification in society; institutions that produce stratification; forces that cause the structure of stratification to vary both over time and across societies; and structures that govern social mobility within and across generations. Intergenerational mobility; social structure and the life course; social inequality and the structure of poverty; careers and labor markets; societal transformation; stratification and mobility research. Instructor: Brady, Keister, Lin, Spenner, or R'Orand. 3 units.

229S. Proseminar in Social Psychology. Selected topics in microsociology and social psychology, including social interaction, decision making, social exchange, group processes, intergroup relations, self and identity, social structure and personality, social networks, and application in organizations and health care. Introduction to social psychology; rational choice and social exchange; sociology of self and identity; group processes and intergroup relations; experimental research; practicum; social psychology. Instructor: Burton, George, Lin, Smith-Lovin, or Spenner. 3 units.

230. Sociology of Religion. Begins with Durkheim's and Weber's different approaches to the sociology of religion. Considers a range of topics, including ritual, religious commitment, conversion, religion and social movements, secularization, social sources of religious variation, and religious influences on people, organizations, and societies. Explores current empirical and theoretical debates. Identifies significant unanswered questions that future research should address. Instructor: Chaves. 3 units. C-L: Religion 248

234. Population, Health and Policy. 3 units. C-L: see Public Policy Studies 224

236S. Experimental Communities. 3 units. C-L: see Visual Arts 236S; also C-L: Cultural Anthropology 236S


290S. Global Responses to the Rise of China. Issues on the impact of globalization on jobs and wages in advanced industrialized countries, the trend of regionalization in international political economy, the new strategies adopted by both advanced industrialized countries and developing countries under the WTO framework, South-North relationship in the era of globalization, the impact of outsourcing through globalization production networks on developing countries, comparative analysis of inequality, and other issues faced by developing countries today. Instructor: Gao. 3 units. C-L: Economics 267S


293S. Social Change, Markets, and Economy in China. Introduction to recent economic, social, and institutional changes in China, with focus on recent (post 1980) periods. Up-to-date descriptive reviews, empirical data, and discussions on historical background, current status, and future perspectives. Instructor: Yi. 3 units. C-L: Economics 269S

298S. Seminar in Selected Topics. Substantive, theoretical, or methodological topics. Restricted to Sociology graduate program majors only. Instructor: Staff. 3 units.

299. Selected Topics. Lecture version of Sociology 299S. 3 units.

299S. Seminar in Selected Topics. Substantive, theoretical, or methodological topics. Instructor: Staff. 3 units.

For Graduate Students Only

301. Current Debates and Professional Concerns in Sociology. A two-semester overview of the sociological research being conducted in the Department, a discussion of current controversies in the discipline, how to prepare for a professional career in sociology, the ethics of doing sociological research, the practice of teaching, how to apply for research grants. Instructor: Staff. 1.5 units.

302. Workshop on Sociological Research. A two-semester workshop in which each student carries out a research project from beginning to end. Weekly seminars offer the opportunity for students to critique each other's work. Instructor: Staff. 3 units.

303. Developing a Dissertation Proposal. A two-semester workshop in which students develop their dissertation proposals. Instructor: Staff. 3 units.

333. Seminar in Political Economy: Macro Level (C-E). 3 units. C-L: see Political Science 333

392. Individual Research in Sociology. Students will conduct on an individual basis research designed to evaluate a sociological hypothesis of their choice. The process must be completed by preparation of a report on this research in adequate professional style. Prerequisite: Sociology 208 or consent of instructor. Instructor: Staff. 3 units.

Statistical Science

Professor Gelfand, Chair (214 Old Chemistry); Professor West, Director of Graduate Studies; Professors Berger, Clark, Dunson, Winkler, and Wolpert; Associate Professors Clyde, Hauser, Reiter, Schmidler; Assistant Professors Li, Mukherjee, Tokdar; Professor Emeriti Burdick and Sacks; Professors of the Practice Banks and Stangl; Associate Research Professor Iversen; Assistant Research Professor Lucas; Adjunct Professor Bayarri; Visiting Associate Professor Dinwoodie; Visiting Assistant Professors Manolopoulou, Page, Shamseldin

The Department of Statistical Science at Duke University offers graduate study leading to the PhD degree in Statistical Science and, for PhD students in other departments at Duke, the MS degree in Statistical Science. The program offers thorough preparation in the theory and methods of statistics, with major emphasis on modern, model-based statistical science, Bayesian and classical approaches to inference, and computational statistics. Students work with some of the world leaders in research in Bayesian statistics, methodology of statistical science, statistical computing, and a range of interdisciplinary areas. A hallmark of the program is the integration of interdisciplinary applications into teaching and research at all levels, reflecting the department's broad and deep working relationships with many other disciplines (biomedical sciences, environmental sciences, genomics, engineering, business administration, social sciences, and others). The rich opportunities for students in interdisciplinary statistical research at Duke is complemented by departmental interconnections at the National Institute of Statistical Sciences (NISS) and Statistical and Applied Mathematical Sciences Institute (SAMSI), and summer research and industrial internships.

Requirements for the PhD degree in statistical science include study of statistics, probability, relevant areas of mathematics, statistical computing, decision sciences, and related areas; passing the qualifying examination (covering those topics) given at the end of the first year, and the doctoral preliminary examination (covering areas of possible research interest) at the end of the second or start of the third year; and completing a dissertation written under the supervision of a faculty advisor. For an up-to-date faculty list and description of the graduate programs in Statistical Science, visit the Web site: http://www.stat.duke.edu.

Statistical Science Courses (STA)

205. Probability and Measure Theory. Introduction to probability spaces, the theory of measure and integration, random variables, and limit theorems. Distribution functions, densities, and characteristic functions; convergence of random variables and of their distributions; uniform integrability and the Lebesgue convergence theorems. Weak and strong laws of large numbers, central limit theorem. Prerequisite: elementary real analysis and elementary probability theory. Instructor:
207. **Probability.** 3 units. C-L: see Mathematics 287

213. **Introduction to Statistical Methods.** Emphasis on classical techniques of hypothesis testing and point and interval estimation, using the binomial, normal, t, F, and chi square distributions. Not open to students who have had Statistical Science 114 or Mathematics 136. Prerequisite: Mathematics 103 (may be taken concurrently) or equivalent, or consent of instructor. Instructor: Li. 3 units.

214. **Probability and Statistical Models.** Theory, modeling, and computational topics in probability and statistics: distribution theory and modeling, simulation and applied probability models in statistics, generation of random variables. Monte Carlo method and integration; Markov Chain Monte Carlo methods; applied stochastic processes including Markov process theory, linear systems theory, and AR models. Latent variable probability models, i.e., mixture models, hidden Markov models, and missing data problems. Discrete and continuous multivariate distributions: linear, multinormal, and graphical models; tools of linear algebra and probability calculus. Statistical computing using Matlab/R. Prerequisite: Statistics 215, 244, and 290. Instructor: Schmidler or West. 3 units.

215. **Statistical Inference.** Classical, likelihood, and Bayesian approaches to statistical inference. Foundations of point and interval estimation, and properties of estimators (bias, consistency, efficiency, sufficiency, robustness). Testing: Type I and II errors, power, likelihood ratios; Bayes factors, posterior probabilities of hypotheses. The predictivist perspective. Applications include estimation and testing in normal models; model choice and criticism. Prerequisite: Statistics 213 and 244 or consent of instructor. Instructor: Li, Wolpert. 3 units.

216. **Generalized Linear Models.** Likelihood-based and Bayesian inference of binomial, ordinal, and Poisson regression models, and the relation of these models to item response theory and other psychometric models. Focus on latent variable interpretations of categorical variables, computational techniques of estimating posterior distributions on model parameters, and Bayesian and likelihood approaches to case analyses and goodness-of-fit criterion. Theory and practice of modern regression modeling within the unifying context of generalized linear models. A brief review of hierarchical linear models. Students expected to use several software packages and to customize functions in these packages to perform applied analyses. Prerequisite: Statistics 213 and 244 or consent of instructor. Instructor: Dunson. 3 units.

217. **Ordinal Data Modeling.** Bayesian and likelihood-based of ordered categorical data and rank data using latent variable constructs. Binary and ordinal regression models, multi-rater ordinal data models, multi-rater rank data models, item-response models, and graded-response models. MCMC estimation. Prerequisites: Statistics 213 or equivalent; working knowledge of a low-level computing language like C, C++, or Fortran. Instructor: Staff. 3 units.

218. **Statistical Data Mining.** Introduction to data mining, including multivariate nonparametric regression, classification, and cluster analysis. Topics include the Curse of Dimensionality, the bootstrap, cross-validation, search (especially model selection), smoothing, the backfitting algorithm, and boosting. Emphasis on regression methods (e.g., neural networks, wavelets, the LASSO, and LARS), classifications methods (e.g., CART, Support vector machines, and nearest-neighbor methods), and cluster analysis (e.g., self-organizing maps, D-means clustering, and minimum spanning trees). Theory illustrated through analysis of classical data sets. Prerequisites: Statistics 114. Instructor: Banks. 3 units. C-L: Computer Science 219

221. **Bayesian Inference and Decision.** 3 units. C-L: see Business Administration 510


231. **Behavioral Decision Theory.** 3 units. C-L: see Business Administration 525; also C-L: Psychology 316

234. **Choice Theory.** 3 units. C-L: see Business Administration 513

240. **Applied Data Analysis for Environmental Sciences.** 3 units. C-L: see Environment 210

242. **Applied Regression Analysis.** 3 units. C-L: see Environment 255

244. **Linear Models.** Multiple linear regression and model building. Exploratory data analysis techniques, variable transformations and selection, parameter estimation and interpretation, prediction, Bayesian hierarchical models, Bayes factors and intrinsic Bayes factors for linear models, and Bayesian model averaging. The concepts of linear models from Bayesian and classical viewpoints. Topics in Markov chain Monte Carlo simulation introduced as required. Prerequisite: Statistics 213 and 290 or equivalent. Instructor: Clyde. 3 units. C-L: Mathematics 217

250. **Numerical Analysis.** 3 units. C-L: see Computer Science 250; also C-L: Mathematics 221

253. **Applied Stochastic Processes.** 3 units. C-L: see Mathematics 216

270. **Statistical Methods for Computational Biology.** 3 units. C-L: see Computational Biology and Bioinformatics 240

271. **Statistical Genetics.** 3 units. C-L: see Computational Biology and Bioinformatics 241

277. **Computational Structural Biology.** 3 units. C-L: see Computer Science 263B; also C-L: Computational Biology and
Bioinformatics 250

278. Computational Gene Expression Analysis. 1 unit. C-L: see Computational Biology and Bioinformatics 221; also C-L: Molec Genetics & Microbiology 221

280. Spatial Statistics. Modeling data with spatial structure; point-referenced (geo-statistical) data, areal (lattice) data, and point process data; stationarity, valid covariance functions; Gaussian processes and generalizations; kriging; Markov random fields (CAR and SAR); hierarchical modeling for spatial data; misalignment; multivariate spatial data, space/time data specification. Theory and application. Some assignments will involve computing and data analysis. Consent of instructor required. Instructor: Gelfand. 3 units.

281. Modern Nonparametric Theory and Methods. Modern nonparametric approaches for exploring and drawing inferences from data. Topics may include: resampling methods, nonparametric density estimation, nonparametric regression and classification, bootstrapping, kernel methods, splines, local regression, wavelets, support vector machines, nonparametric modeling for random distributions. Classical and Bayesian perspectives. Consent of instructor required. Instructor: Dunson. 3 units.

280. Spatial Statistics. Modeling data with spatial structure; point-referenced (geo-statistical) data, areal (lattice) data, and point process data; stationarity, valid covariance functions; Gaussian processes and generalizations; kriging; Markov random fields (CAR and SAR); hierarchical modeling for spatial data; misalignment; multivariate spatial data, space/time data specification. Theory and application. Some assignments will involve computing and data analysis. Consent of instructor required. Instructor: Gelfand. 3 units.

290. Modern Statistical Data Analysis. Introduction to statistical thinking, data management and collection, sampling and design, exploratory data analysis, graphical and tabular displays, summarizing data. Introduction to applied work. Computer orientation, statistical packages and operating systems, especially unix on high-speed workstations, and the statistical package S-Plus. Graphics and numerical computing. Examples from various disciplines. Instructor: Clyde or Reiter. 3 units.


293. Special Topics in Statistics. Prerequisite: Statistics 213 or consent of instructor. Pass/Fail grading only. Instructor: Staff. 3 units.

294. Special Topics in Statistics. Prerequisite: Statistics 213 or consent of instructor. Pass/Fail grading only. Instructor: Staff. 3 units.

294A. Special Topics in Statistics. Prerequisite: Statistics 213 or consent of instructor. Credit/Non-Credit grading only. Instructor: Staff. 2 units.

295. First-Year Seminar. Weekly seminar covering a variety of statistical subjects. Coregistration in Statistics 213 and Statistics 244 or consent of instructor. Instructor: Staff. Variable credit.

297. Topics in Probability Theory. 3 units. C-L: see Mathematics 288


376. Advanced Modeling and Scientific Computing. An introduction to advanced statistical modeling and modern numerical methods useful in implementing statistical procedures for data analysis, model exploration, inference, and prediction. Topics include simulation techniques for maximization and integration. Prerequisite: Computer Science 221 or equivalent. Instructor: Schmidler or West. 3 units.

390. Statistical Consulting Workshop. Under faculty supervision, students address and solve consulting problems submitted to ISDS's campus-wide consulting program, and present their solutions to the class. May be taken more than once. Consent of instructor required. Instructor: Staff. 1 unit.


**Structural Biology and Biophysics**

Associate Professor Oas, *Director* (biochemistry); Professor D. Richardson, *Director of Graduate Studies* (biochemistry); 30 participating faculty members in six departments

This is an admitting program.

A certificate is also available in this program.

The program in structural biology and biophysics at Duke centers on those research endeavors that use physical measurements to study biological macromolecules and their interactions, where the details of molecular structure are...
critical to understanding the biological problem in question. The focus is on understanding molecular structure/function at atomic resolution; the breadth extends to detecting molecular events and describing structural relationships in a chemically meaningful way, and relating atomic-level with higher-order structures. There is a commonality in the intellectual approaches and experimental techniques. Research problems addressed within the University Program in Structural Biology and Biophysics include: 3-D structure determination by crystallography and NMR; molecular assemblies studied by various diffraction, spectroscopy, and microscopy techniques; protein folding; molecular modeling and design studies and their direct experimental testing; and functional studies in biochemistry, genetic mechanisms, drug interactions, membrane systems, and so on, for which the details of molecular geometry are central to interpreting the experiments.

Participating students may receive a certificate from the Structural Biology and Biophysics Program in addition to the doctoral degree from their home department. Requirements for the certificate ordinarily will include the core courses (Proteins and Enzymes, Physical Biochemistry I, Physical Biochemistry II, Structure of Biological Macromolecules, Membrane Biophysics and Molecular Biophysics Seminar), lab rotations with Structural Biology and Biophysics faculty, presenting and attending seminars, and an appropriate thesis topic and committee. However, the curriculum can be tailored for students with special interests and backgrounds.

Certificate Requirements:
- Complete a certificate form from SBB and have it signed by the DGS. Submit to the department early in the semester.
- Required courses in SBB curriculum:
  1) Proteins and Enzymes
  2) Physical Biochemistry I
  3) Physical Biochemistry II
  4) Structure of Biological Macromolecules
  5) Membrane Biophysics
  6) Molecular Biophysics Seminar
- Lab rotations with Structural Biology and Biophysics faculty.
- Presenting and attending weekly seminar series.
- An appropriate thesis topic, and have one program faculty member on their thesis committee.

For further information about the University Program in Structural Biology and Biophysics, contact the program office at sbb@biochem.duke.edu or at Duke University, Box 103855 DUMC, Durham, North Carolina 27710, or visit http://sbb.duke.edu/.

Structural Biology and Biophysics Courses (SBB)
222. Structure of Biological Macromolecules. 3 units. C-L: see Biochemistry 222; also C-L: Computational Biology and Bioinformatics 252
258. Structural Biochemistry I. 2 units. C-L: see Biochemistry 258; also C-L: Cell and Molecular Biology 258, Cell Biology 258, University Program in Genetics 258, Immunology 258, Computational Biology and Bioinformatics 258
259. Structural Biochemistry II. 2 units. C-L: see Biochemistry 259; also C-L: Cell Biology 259, Immunology 259, Computational Biology and Bioinformatics 259, University Program in Genetics 259
263. Algorithms in Structural Biology and Biophysics. 3 units. C-L: see Computer Science 263; also C-L: Computational Biology and Bioinformatics 263
291. Physical Biochemistry. 3 units. C-L: see Biochemistry 291
292. Advanced Physical Biochemistry. Transient kinetics, computational methods, multidimensional NMR, x-ray crystallography, thermodynamics of association. Prerequisite: Structural Biology and Biophysics or consent of instructor. Instructor: Oas. 3 units.
345. Molecular Biophysics Seminar. Required of all MBP students. Instructor: Oas. 1 unit.
346. Structural Bio & Biophysics Seminar. Weekly seminars are presented by program students, beyond their first year, faculty members, or guest speakers. (Required of all SBB Students.) Instructor: Oas. 1 unit.

Teaching College Biology
Julie A. Reynolds, Program Director
A certificate is available in this program.
The Certificate in Teaching College Biology aims to enhance the professional development of graduate students by preparing them to teach biological sciences in academic venues that range from community colleges to Research I
Universities. In this program, graduate students work with faculty from nearby partner institutions (e.g., Durham Technical Community College, Elon University, and Meredith College) and from Duke to develop as teachers and to gain awareness about the roles of faculty. These experiences help to prepare graduate students for the academic job market. Program participants take courses on pedagogy, are mentored by faculty at partner institutions, gain practical teaching experience, and receive formal evaluation of their teaching. These requirements are designed to be flexible enough to be pursued alongside full-time disciplinary studies yet ensure that participants are rigorously trained in biological pedagogy.

Requirements:
• Submit required forms no later than early in the semester in which you intend to finish.
• Program will enhance students’ skill as teachers, and their understanding of issues in teaching/learning. It is flexible enough to be pursued alongside full-time disciplinary studies.
• Must complete work in four different areas:
  • Courses and workshops on pedagogy, i.e., BIO 390: Seminar (usually offered in spring semester), with guest speakers and/or potential mentors.
  • Faculty mentorship. Once you have some ideas about a mentor with whom you might like to work, speak to the program director to set up the formal arrangements.
  • Practical teaching experience, fulfilled either through a TA-ship or through mentorship.
  • Evaluation of teaching.

For more information visit our Web Site at: [http://www.biology.duke.edu/teachcert/](http://www.biology.duke.edu/teachcert/) or contact the Program Director, Julie Reynolds, [julie.a.reynolds@duke.edu](mailto:julie.a.reynolds@duke.edu).

Women’s Studies

Professor Khanna (English and literature), Director (210 East Duke Building); Professor Wiegman (literature); Associate Professors Campt (history), Rudy, Weeks, Wilson (cultural anthropology); Assistant Professor Lamm; Associate Faculty: Professors Allison (cultural anthropology), Brody (African and African American Studies), Fulkerson (divinity), Holloway (English), Koonz (history), Nelson (cultural anthropology), Silverblatt (cultural anthropology), Wald (English); Associate Professors Holland (English), Lubiano (African and African American studies), Mottahedeh (literature), Piot (cultural anthropology and African and African American Studies), Stein (cultural anthropology); Assistant Professor Rojas (Asian and Middle Eastern Studies)

A certificate is available in this program.

Women's Studies is part of an historical educational enterprise inaugurated by social movements and dedicated to the study of identity as a complex social phenomenon. In the field’s first decades, feminist scholarship reoriented traditional disciplines toward the study of women and gender and developed new methodologies and critical vocabularies that have made interdisciplinarity a key feature of Women's Studies as an autonomous field. Today, scholars continue to explore the meaning and impact of identity as a primary—though by no means transhistorical or universal—way of organizing social life by pursuing an intersectional analysis of gender, race, sexuality, class, and nationality. In the classroom, as in our research, our goal is to transform the university's organization of knowledge by reaching across the epistemological and methodological divisions of historical, political, economic, representational, technological and scientific analysis. In our program’s dual emphasis on interdisciplinarity and intersectionality, we offer students new knowledge about identity while equipping them with a wide range of analytical and methodological skills.

Women's Studies at Duke is a focal point within the university for the study of women, gender, and feminist theories—a structure that allows graduate students to address complex issues beyond their traditional disciplinary and classroom boundaries and to explore problems in ways that connect theories and approaches of different disciplines. Women's Studies serves students’ intellectual interests by offering credit courses, housing a variety of research projects, and implementing programs for diverse audiences. Graduate students can earn a four-course Certificate in Feminist Studies and are encouraged to teach introductory or special topics courses. Professional students and doctoral candidates may join a scholarly society that deepens their knowledge of the field of Women's Studies and provides a cohesive, supportive community. All affiliated students on the mailing list receive newsletters, lecture notices and invitations to special events.

Requirements:
Open to Duke students enrolled in PhD programs and graduate inter-institutional students (UNC, NCSU, and NCCU).

• Four course requirements:
  1) WST 220: Foundations in Feminist Theory (required).
  2) Two additional graduate courses in Women’s Studies at Duke University.
3) A fourth graduate course in Women’s Studies, or a graduate course offered by another department/program that focuses on women, gender, sexuality, race, and/or feminism – must be approved by the program.

- Must incorporate women, gender, sexuality, or feminism topics as a significant aspect of preliminary examination and/or dissertation project.
- Include a women’s studies core, associate, adjunct, or affiliated faculty member on their preliminary examination and dissertation committees.
- Certificate recipients are eligible to apply for dissertation fellowships within the program.

For additional information, visit the program website at: [http://womenstudies.duke.edu/graduate-certificate](http://womenstudies.duke.edu/graduate-certificate).

**Women's Studies Courses (WOMENST)**

**205. Debates in Women's Studies.** This course is designed for Masters and Professional Schools students and for Ph.D. students with little or no background in feminist scholarship. It introduces students to the basic conceptual tools of feminist inquiry by way of an examination of some of the key debates in feminist studies. Instructor: Staff. 3 units.

**208S. Economics of the Family.** 3 units. C-L: see Economics 208S

**210S. Selected Topics in Feminist Studies.** A seminar in contemporary issues, methodology, and/or selected theoretical questions pertaining to feminist scholarship. Instructor: Staff. 3 units.

**211S. Gender, Identity, and Public Policy.** 3 units. C-L: see Public Policy Studies 211S; also C-L: Political Science 216S

**212S. Film Feminisms.** 3 units. C-L: see Literature 212S

**219S. Topics in Sexuality and Gender Studies.** 3 units. C-L: see Italian 220S

**220. Foundations in Feminist Theory.** Required for all students pursuing the graduate certificate in Women's Studies, this course serves as an in-depth introduction to the various theoretical frameworks that have and continue to inform scholarship in the field of Women's Studies. It explores differences between distinct feminist theoretical traditions (Marxist feminism, poststructuralism, psychoanalysis, queer theory) and seeks to historicize accounts of identity, difference, social movement, globalization, nationalism, and social change. Consent of instructor required. Instructor: Staff. 3 units. C-L: Literature 220

**230. Feminist Knowledge, Interdisciplinarity, and Social Change.** This course explores feminism as a knowledge formation by considering Women's Studies as a specific interdisciplinary, politics, and epistemological project in relation to feminist studies in the disciplines. The course is highly recommended for students seeking part or full time academic employment in Women's Studies. Consent of instructor required. Instructor: Staff. 3 units.

**240S. Critical Genealogies.** This course serves as an in-depth investigation into the many different theoretical traditions that inform interdisciplinary feminist studies. Specific foci include Marxist-feminism, poststructuralism, feminist film theory, psychoanalysis, French feminism, postcolonial theory, deconstruction, the Frankfurt school, etc. Instructor: Staff. 3 units.

**281S. Masculinities.** 3 units. C-L: see Cultural Anthropology 281S

**290. Interdisciplinary Research Workshop.** This course focuses on research and writing, paying particular attention to the intellectual and methodological demands of interdisciplinary knowledge production. Instructor: Staff. 3 units.

**297S. Teaching Race, Teaching Gender.** 3 units. C-L: see African and African American Studies 297S; also C-L: History 297S, Literature 225S

**300. Advanced Topics in Feminist Studies.** A selected topics seminar on emergent theoretical and empirical questions in feminist scholarship. Prerequisite: must have taken either Women's Studies 211, 212, 213, or 214 or have consent of instructor. Instructor: Staff. 3 units.

**306S. Space, Place and Power.** 3 units. C-L: see Cultural Anthropology 306S; also C-L: Literature 305S

**320. The Pedagogy of Women's Studies.** Advanced seminar focusing on the teaching of undergraduate women’s studies, including the design and implementation of interdisciplinary syllabi and related classroom materials, practices of instruction, and feminist pedagogical theories. May include internships or teaching collaborations with Women's Studies faculty. Instructor consent required. Instructor: Staff. 3 units.

**360. Interdisciplinary Debates.** Designed for advanced graduate students, this course will highlight current debates in feminist studies through a topical approach that draws on faculty research and expertise. Instructor: Staff. 3 units.

**391. Tutorial in Special Topics.** Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

**392. Tutorial in Special Topics.** Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.
Special Study Centers, Programs, and Opportunities

UNIVERSITY INSTITUTES & CENTERS

Duke Global Health Institute

The Duke Global Health Institute (DGHI) works to reduce health disparities in our local community and worldwide. Recognizing that many global health problems stem from economic, social, environmental, political and health care inequalities, DGHI brings together interdisciplinary teams to solve complex health problems and to train the next generation of global health scholars. The institute offers a new masters program and graduate certificate in global health, as well as a graduate certificate in health policy, offered through DGHI’s affiliate, the Center for Health Policy. Other opportunities are available to students in U.S. and international fieldwork and research. For more information, visit the DGHI Web site at: http://globalhealth.duke.edu/.

Duke Institute for Brain Sciences

The Duke Institute for Brain Sciences (DIBS) is a cross-school, campus-wide, interdisciplinary institute dedicated to building an interactive community of brain science research and scholarship and advancing interdisciplinary research and education that transforms our understanding of brain function and translates into innovative solutions for health and society. DIBS encourages innovation and collaborations that transcend the boundaries of traditional disciplines, bringing together a diverse community of academics from the biomedical sciences, social sciences, physical sciences, humanities, law, business, public policy, mathematics, computer science and engineering. For more information, visit the DIBS Web site at: http://www.dibs.duke.edu/.

Center for Cognitive Neuroscience

The Duke Institute for Brain Sciences (DIBS) Center for Cognitive Neuroscience (CCN) serves as the central focus for research, education, and training in the biological, psychological, and computational mechanisms mediating higher brain functions, including perception, attention, memory, emotion, social and behavioral, decision-making, and consciousness. Cognitive neuroscience is by its nature interdisciplinary, and addresses longstanding questions about brain and mind from new perspectives that cut across traditional intellectual and departmental boundaries. To advance this agenda, the DIBS-CCN and its activities bring together faculty from multiple schools in the University, including Arts and Sciences, the Medical School, Pratt School of Engineering, and Fuqua Business School, representing departments of Psychology and Neuroscience, Neurobiology, Psychiatry, Biomedical Engineering, Philosophy, Evolutionary Anthropology, Computer Science, Linguistics, Neurology, Radiology, Finance, and Marketing.

Students can obtain post-graduate training in cognitive neuroscience on either of two tracks. The Graduate Admitting Program in Cognitive Neuroscience is an admitting program for newly entering PhD graduate students, who complete coursework and laboratory rotations within the program before choosing during their second year an advisor and a department in which to earn their PhD degree. Alternatively, students admitted directly to a departmental program can complete coursework and research that lead to a Certificate in Cognitive Neuroscience. For additional information, see the entry “Cognitive Neuroscience” on page 80 in this Bulletin or contact beth.peloquin@duke.edu. For more information, visit the DIBS-CCN Web site at http://www.mind.duke.edu/.

Institute for Genome Sciences & Policy

The Institute for Genome Sciences & Policy is a multi- and interdisciplinary network of centers, research programs, and educational activities that together constitute an integrated, campus-wide approach to advancing the Genome Revolution. The IGSP is distinguished by its breadth and its purposeful focus on health and social policy. We bring together scientists, engineers, physicians, lawyers, policymakers, business leaders, economists, ethicists, humanists, and students to explore the genome and embrace its potential for improving human health and exploring the world and our place in it.
IGSP investigators, members, and students address far-reaching issues such as genomics and personalized medicine, genetic discrimination, the nature of humanity, comparative genome evolution, intellectual property, the meaning of genome variation, large-scale data storage and analysis, and national health and science policy.

The IGSP is comprised of faculty and students from across Duke University and is organized in a network of Centers and related programs that together form an integrated approach to advancing the Genome Revolution and addressing its implications for health and society. Each center provides core competencies and areas of scholarship that comprise the comprehensive scope of the IGSP’s mission.

• Center for Applied Genomics and Technology
• Center for Genome Ethics, Law and Policy
• Center for Genomic Medicine
• Center for Bioinformatics and Computational Biology
• Center for Systems Biology
• Center for Human Genome Variation
• Center for Evolutionary Genomics

While the IGSP is the major focal point on campus for the study of genome sciences and policy, it collaborates with other multidisciplinary research units at Duke doing related work in genomics.

**John Hope Franklin Humanities Institute**

Founded in 1999, the John Hope Franklin Humanities Institute (FHI) is a built on a fundamentally collaborative model fitting Duke’s emphasis on facilitating interdisciplinary cross-fertilization. Through an array of innovative programs, we seek to encourage the conversations, partnerships, and collaborations that are continually stimulating creative and fresh humanistic research, writing, and teaching at Duke. The FHI’s core program, the Annual Seminar, has supported close to 100 research projects, including work by over 60 duke faculty members, over 35 Duke graduate students, nine postdoctoral fellows, and six Duke librarians since its inception. The FHI also presents numerous high-level, engaging, often collaboratively-sponsored public programs, including lectures, panels, conferences, colloquia, as well as film screenings and other arts and media programs. With the staff of the Franklin Center, FHI also co-sponsors the long-running and popular lunchtime conversation series, Wednesdays at the Center.

For more information, visit the FHI Web site at: [http://www.fhi.duke.edu/](http://www.fhi.duke.edu/)

**Kenan Institute for Ethics**

The Kenan Institute for Ethics at Duke University is an interdisciplinary "think and do" tank committed to understanding and addressing real-world ethical challenges facing individuals, organizations, and societies worldwide.

• We foster students’ capacity for ethical decision-making and develop ethical leaders.
• We conduct interdisciplinary research that has practical implications.
• We shape public policy and institutional practices through partnerships with businesses, think tanks, non-profits, and policy-makers.

The Institute promotes ethical reflection and engagement through its research, education, and practice in three core areas: Moral Education and Development, Organizational Ethics, and Civic and Global Ethics.

For more information, contact the Kenan Institute for Ethics, Box 90432, 102 West Duke Bldg., Durham, NC 27708; (919) 660-3033; [http://www.dukeethics.org/](http://www.dukeethics.org/).

**Nicholas Institute for Environmental Policy Solutions**

Created in 2005, The Nicholas Institute for Environmental Policy Solutions seeks to address some of the world’s most pressing environmental problems through scientifically grounded, rigorous, balanced nonpartisan policy analysis and broad-based dissemination of the Institute’s work. With the Nicholas School of the Environment and Earth Sciences, the Institute draws on the unparalleled resources of the Duke University community, from the School of Business and the Law School to the Medical Center, the policy and engineering schools and other Duke resources, as well as on the considerable expertise of partners in industry, government, environmental organizations, and other academic institutions.

This combination has enabled the Nicholas Institute to become a leading policy institute with a core staff and resident faculty dedicated to helping frame the environmental agenda by focusing on important problems and helping develop and recommend effective policies based on unbiased information and careful analysis of the issues, including the politics surrounding policy problems. Students are involved with the Institute through research and policy projects and collaborations with faculty and staff.

**Social Science Research Institute**

The Social Science Research Institute (SSRI) strives to be a resource to all social science departments, programs
and centers at Duke. SSRI brings together researchers with interests in various social science research areas through its facilities, which are equipped to conduct and communicate social science research that attracts and trains scholars engaged in research and interested in collaboration. SSRI also assists research development by administratively supporting innovative, externally funded research.

In addition, SSRI's affiliates and programs are dedicated to carrying out studies and host seminars that move society toward rational and informed discussions:

- CCFP - Center for Child and Family Policy
- CGGC - Center on Globalization, Governance & Competitiveness
- DIISP - Duke Interdisciplinary Initiative in Social Psychology
- DuPRI - Duke Population Research Institute
- PARISS - Program for Advanced Research in the Social Sciences
- REGSS - Center for the Study of Race, Ethnicity and Gender in the Social Sciences

Several SSRI affiliates offer research opportunities and funding, workshops and other collaborative programs. In addition, the SSRI affiliate PARISS offers a graduate Certificate in Advanced Quantitative Methods in the Social Sciences. The goal of SSRI's programs and affiliates is to encourage, promote, facilitate, and execute interdisciplinary research in areas related to social science. For more information, visit the SSRI Web site at: \[http://www.ssri.duke.edu/\].

The Center for Child and Family Policy, an SSRI-affiliated center, brings scholars from many disciplines together with students, policymakers, and practitioners to address problems facing children in contemporary society. The Center is a national leader in addressing issues of early childhood adversity, education policy reform, youth violence and problem behaviors, and adolescent substance abuse prevention. The Center bridges the gap between research and policy by assisting policymakers in making informed decisions based on sound evidence and research.

The interdisciplinary Center for Child and Family Policy is located in Rubenstein Hall, Box 90545, Durham, NC 27708-0545; phone (919) 613-9303; \[http://www.childandfamilypolicy.duke.edu/\].

The Duke Population Research Institute (DuPRI), an SSRI-affiliated center, promotes a variety of activities related to the advanced study of demographic issues and supports the pursuit of advanced degrees in sociology, economics, public policy, and other disciplines related to population studies. DuPRI’s faculty members and research scientists have been awarded a large number of research grants spanning a full range of population topics and welcome the expansion of intellectual activity at Duke devoted to population research in the classroom as well as in the laboratory and in the field. Inquiries for training and research opportunities, especially as related to sociology, biology, and health science, may be directed to DuPRI faculty member Dr. Kenneth C. Land, Director of the Center for Population Health and Aging, Sociology Department, Box 90088, Durham, NC 27708-0088. Inquiries for all other training and research opportunities related to population research, such as those related to economics, public policy, and psychology, may be directed to DuPRI faculty member Dr. V. Joseph Hotz, Duke University, Economics Department, Box 90097, Durham, NC 27708-0097.

SCHOOL-BASED INTERDISCIPLINARY CENTERS

There are more than 60 interdisciplinary centers based within Duke’s ten schools, many of which offer programs, certificates, research opportunities, and other programming for graduate students. More information about all of the interdisciplinary institutes and centers can be found on the Interdisciplinary Studies Web site at: \[http://interdisciplinary.duke.edu/\].

INTERNATIONAL CENTERS

Asian/Pacific Studies Institute (APSI)

The Asian/Pacific Studies Institute (APSI) is the focal point of research and teaching on the Asian/Pacific region at Duke University. Started in 1981, today APSI has more than 40 fulltime faculty members at Duke and 30 affiliated faculty members from regional universities. It is the largest center for research and teaching on East Asia in the southeast. The Institute offers an interdisciplinary MA program in East Asian Studies, as well as a joint JD/MA program. There is also a certificate program for students pursuing other graduate degrees who wish to document their specialization in East Asia. APSI organizes conferences, a speaker series, research clusters, a visiting scholar program, and the Duke Study in China Program. 323A Trent Drive Hall, Box 90411, Duke University, Durham, North Carolina 27708-0411. Send e-mail to: \[apsi@duke.edu\] or visit our Web page at: \[http://www.duke.edu/APSI/\].

Center for Canadian Studies

Duke has a strong tradition in Canadian Studies dating back more than three decades. Over the years, we have graduated more than 100 PhDs whose work has focused on Canada. Today, these former students teach at leading universities across Canada and the United States.

We also have a strong tradition of Canadian speakers, including prime ministers Pierre Trudeau, Brian Mulroney,
and Jean Chrétien. We also have Canadian faculty members including visiting scholars.

The Center for Canadian Studies maintains an active research program for faculty. The Center also supports the research of a number of graduate students and offers undergraduates the option of a second major or a minor in Canadian Studies.

For more information, contact the Center for Canadian Studies Program, P.O. Box 90422, 2204 Erwin Road, Durham, North Carolina 27708; or visit the Web site at: http://www.jhfc.duke.edu/canadianstudies/.

Center for European Studies

The Duke Center for European Studies was established in 1989. In 1994 the U.S. Department of Education awarded the consortium with a Title VI grant and designated it as a National Resource Center. This grant was renewed for another three years in 1997. In the summer of 1998, the European Union awarded the Center a three-year grant, and it became one of the ten official European Union Centers in the United States. The Duke Center for European Studies brings together a depth and quality of faculty drawn from highly regarded departments in the humanities, social sciences, law, business and public policy.

The Center promotes interdisciplinary programs, courses, and research that directly address questions concerning Europe and the European Union. The Center’s goal is to ensure that faculty, students, and the larger community have access to the finest scholarship and the most current resources on Europe. The Center offers a Graduate Certificate in Interdisciplinary European Studies to those students meeting the requirements listed on the Center Web site (see below). The Center hosts conferences, workshops, and visiting scholars, supports a graduate student colloquium and faculty/student working groups on focused research lines. The Center also supports Duke faculty and graduate students with academic year research grants and travel awards.

For further information, please contact the Center for European Studies, Room 299, John Hope Franklin Center, 2204 Erwin Road, Box 90406, Durham, NC 27708; telephone 919.684.6449; or check the center Web site at: http://www.jhfc.duke.edu/ces.

John Hope Franklin Center for Interdisciplinary and International Studies

The John Hope Franklin Center for Interdisciplinary and International Studies is a unique consortium of programs committed to revitalizing notions of how knowledge is gained and exchanged. Participants from a broad range of disciplines converge to explore intellectual issues, including some of the most pressing social and political themes of our time: race and race relations, the legacy of the African-American experience, equality and opportunity among diverse populations, and the implications of accelerated globalization. At its core, the Center claims an intrepid and daring mission: to bring together humanists and those involved in the social sciences in a setting that inspires vigorous scholarship and imaginative alliances. In this way, historians, artists, literary scholars, and philosophers contribute to a rich understanding of moral and ethical issues. For more information, visit the center’s Web site at: http://www.jhfc.duke.edu/.

Center for International Studies

The Center for International Studies is one of the major coordinating units in the University that stimulates dialogue and research on global issues. The Center sponsors a number of faculty committees on major world regions and on transnational analytical themes. As a U.S. Department of Education National Resource Center in International Studies, the Center funds a series of courses on global issues of interest to undergraduate and graduate students. The Department of Education grant also supports Foreign Language and Area Studies Fellowships for advance language training in critical languages. The competition is open to graduate and professional students. In addition, the Center sponsors a program of awards for graduate students who wish to undertake summer research abroad as well as non-credit graduate seminars. For more information contact the Duke University Center for International Studies, 2204 Erwin Road, Box 90404, Durham, North Carolina 27708-0404, Web site: http://ducis.jhfc.duke.edu/

Center for Latin American and Caribbean Studies

The Center for Latin American and Caribbean Studies coordinates graduate education in Latin American and Caribbean studies, and promotes research and dissemination of knowledge about the region. Chaired by Professor Gilbert W. Merkx, the Council on Latin American Studies oversees the activities of the Center. The Council is made up of Latin Americanist faculty and staff members representing Arts and Sciences disciplines as well as professional schools. The Center sponsors a speakers series which provides a forum for presentations by visiting Latin Americanists from throughout the U.S. and overseas, as well as Duke and UNC faculty and graduate students. Each year, the Center also cosponsors a number of conferences and other special events, including the annual Latin American Labor History Conference. Through the Consortium in Latin American Studies at UNC-Chapel Hill and Duke University, graduate students can take advantage of funding opportunities and participate in research and training working groups in various fields of interest.

For additional information about Latin American and Caribbean Studies at Duke and courses with Latin American and Caribbean content offered by departments, see the section on “Courses of Instruction” in this bulletin. Graduate students interested in obtaining the Certificate in Latin American and Caribbean Studies, or the Certificate in Latin American Cultural Studies, should contact the Academic Program Coordinator. For other inquiries, please
OTHER CENTERS, PROGRAMS, AND OPPORTUNITIES

Center for Advanced Computing and Communication

The Center for Advanced Computing and Communication (CACC) is a joint effort of Duke University and North Carolina State University. Its research goal is to create concepts, methods and tools for use in the analysis, design and implementation of advanced computer and communication systems. The Center strives to carry out basic and applied research on fundamental problems with both industrial and academic relevance, to transfer these results to members, and to provide students with a unique and challenging educational opportunity.

For information, contact Kishor S. Trivedi, Director, Center for Advanced Computing and Communication, Box 90291, Duke University, Durham, North Carolina, 27708-0291.

Center for the Study of Aging and Human Development

The center is a multidisciplinary program devoted to research, training, and clinical activities in gerontology and geriatrics. Although the center does not offer degrees, the varied programs, research laboratories, and clinical settings provide a context and resource for undergraduate and graduate students and for health professionals with special interests in adult development and aging. The center conducts multidisciplinary, two-year programs for postdoctoral fellows interested in focused training for independent research on many varied aspects of aging and adult development. Resources of this all-university program include data from two longitudinal studies, a wide range of archival data of special interest to social scientists, a human subjects registry, core resources of the NIA-funded Claude Pepper Center, and the center’s basic and applied research laboratories. A division of geriatrics coordinates research, training, and services related to the care of older adults. Undergraduate and graduate students of the university are welcome to inquire about participation in all programs at the center.

Inquiries should be addressed to Harvey Jay Cohen, MD, Director, Duke University Center for the Study of Aging and Human Development, Box 3003, Duke University Medical Center, Durham, North Carolina 27710, or visit the Web site at http://www.geri.duke.edu/ for more information.

Center for Documentary Studies

The Center for Documentary Studies, established in 1989, supports interdisciplinary teaching and research along with the practice and dissemination of documentary work. The center teaches, engages in, and presents documentary work grounded in collaborative partnerships and extended fieldwork that uses photography, film/video, audio, and narrative writing to capture and convey contemporary memory, life, and culture. The Center’s graduate-level research focuses on a collaborative project titled “Behind the Veil: Documenting African American Life in the Jim Crow South,” directed by Duke professors William Chafe, Raymond Gavins, and Robert Korstad, but other research opportunities also exist. Graduate students may participate in a variety of courses that the center offers under the auspices of several Duke departments and programs, including art, history, public policy studies, English, education, and cultural anthropology. Center-sponsored projects offer a limited number of assistantships to graduate students in the arts and humanities.

For more information, check the CDS Web site at http://cds.aas.duke.edu/ or contact the Director, Center for Documentary Studies, 1317 West Pettigrew Street, Durham, NC 27705. Telephone: 919-660-3663. Fax: 919-681-7600.

Oak Ridge Associated Universities

Since 1946, students and faculty of Duke University have benefited from membership in Oak Ridge Associated Universities (ORAU). ORAU is a consortium of 100 doctoral-granting academic institutions and a contractor for the U.S. Department of Energy (DOE) located in Oak Ridge, Tennessee. ORAU member universities share the common objective of advancing scientific research and education by creating mutually beneficial collaborative partnerships involving academe, government, and industry. ORAU’s emphasis is on developing and promoting partnerships with national laboratories — in particular, Oak Ridge National Laboratory (ORNL).

For decades, ORAU has recruited students and recent graduates to pursue degrees and conduct research in disciplines of interest to federal agencies with science research missions. ORAU has helped direct the educational paths and research careers of more than 35,000 individuals through:

• graduate fellowships
• undergraduate scholarships
• postgraduate internships
• postdoctoral research appointments
• faculty research programs
• other science education programs

In addition, through its management of the Oak Ridge Institute for Science and Education (ORISE), ORAU strives to advance science education and research programs. ORISE creates opportunities for collaboration through partnerships with other DOE facilities, other federal agencies, the academic community, and industry.

Fundamental to ORISE’s mission objectives are:

• Strengthening our nation’s research and development enterprise through education and research participation programs

• Ensuring the readiness of our nation to respond to terrorist incidents and other emergencies

• Protecting workers, the public, and the environment through research, outreach, and verification activities

For more information about ORAU and its programs, contact Duke’s ORAU Councilor: Judith Dillon, Director, Office of Research Support, (919) 684-3030; or refer to ORAU’s Web site: http://www.orau.org/.

Office of Research Support

The Office of Research Support (ORS) assists Duke faculty, students, and staff in the following areas:

• For Duke Campus faculty, students, and staff, ORS reviews and approves all proposals (including graduate fellowships) requiring an institutional signature. For additional information on this process please see http://www.ors.duke.edu/grants-contracts-and-compliance

• For non-medical human subjects research conducted on Campus, the Office for Human Subjects Protections coordinates the Institutional Review Board (IRB), which must approve all protocols before research can proceed. For further information, please see http://www.ors.duke.edu/research-with-human-subjects

• For faculty, students, and staff throughout Duke University (Campus and Medical Center), ORS provides information on funding opportunities including specific funding information for Graduate and Professional Students. For a current list of opportunities, please see http://www.ors.duke.edu/orsmanual/graduate-and-professional-student-funding

• For faculty, students, and staff throughout Duke University (Campus and Medical Center), the Office of Export Controls provides assistance on travel to embargoed countries, transport of computers and other equipment overseas, and exports in general. For further information please see http://www.ors.duke.edu/export-controls.

ORS offers extensive information on external funding for thesis and dissertation research, postdoctoral fellowships, travel awards, and other research and training support. Online resources include two funding-opportunities databases and Duke’s Funding Alert newsletter to which students may subscribe at http://researchfunding.duke.edu/subscribe.asp.

As well, ORS offers regular workshops for graduate students on how to use its online funding-information resources. For a schedule of upcoming workshops, please refer to: http://www.ors.duke.edu/workshop-and-training. Students may also schedule an appointment to visit ORS to receive one-on-one assistance and to use resources, such as the Foundation Directory Online, which are not available via the ORS Web site. Once you are ready to begin writing a grant or fellowship application, you will need to work with ORS again for institutional review of your proposal, and you will also need to begin the process of obtaining IRB approval for any human-subjects protocol that may be part of your research.

For all of these services, please call ORS at (919) 684-3030.

Center for Tropical Conservation

The Center for Tropical Conservation was established to focus the activities of Duke faculty and students who share a common concern for tropical biodiversity. The primary goal of the Center is to unite biological scientific inquiry with conservation advocacy. The Center serves to gather and disseminate pertinent information; to promote and coordinate research relevant to biodiversity and the sustainable development of natural resources; and to sponsor interdisciplinary workshops and courses.

Inquiries should be addressed to Professor John W. Terborgh, Co-Director, Center for Tropical Conservation, 3705-C Erwin Road, Simons Building, P.O. Box 90381, Durham, North Carolina 27708-0381.

Organization for Tropical Studies

Duke University is a member and the administrative home of the Organization for Tropical Studies (OTS), a nonprofit consortium that provides leadership in education, research, and the responsible use of natural resources in the tropics. OTS regularly offers the following English language courses in Costa Rica: Tropical Biology: An
Ecological Approach (once per year - OTS-1 January to March even-numbered years, and OTS-3 June to August odd-numbered years); Tropical Plant Systematics (OTS-9 June to July even numbered years). OTS regularly offers the following courses in Spanish: Ecología Tropical y Conservación (OTS-2 January to March in Costa Rica); Ecosistemas Amazónicos y Cambios Globales (OTS-13 September to October in Peru); Sistemática de Plantas Tropicales (OTS-18 June to July in Costa Rica odd numbered years). Additionally, five or six 2-week graduate courses covering various specialized topics in tropical ecology are offered each year. Students can also apply for courses in East Africa through OTS. Graduate research fellowships are available from OTS on a competitive basis for research conducted at OTS field stations in Costa Rica (La Selva, Palo Verde, Las Cruces). Outstanding proposals for research at other locations may also be considered when sufficient funds are available. Proposals are accepted twice each academic year. Information about OTS courses and fellowships is available from Duke's OTS delegates: William Morris and Gregory Wray, both in the Department of Biology.

For more information contact OTS at 410 Swift Avenue, Durham, North Carolina 27708; Phone: 919-684-5774, e-mail: ots@duke.edu, or visit the Web site at: http://www.ots.duke.edu.
Resources for Study

The Libraries

The Duke University Libraries include the five libraries of the Perkins Library System and the libraries affiliated with the Divinity School, the Fuqua School of Business, the Law School and the Medical Center. Graduate students can borrow books and journals from any campus library and can use most electronic resources, including electronic journals and databases, from anywhere on or off campus. The Web site http://library.duke.edu is a gateway to the individual Web sites of all the campus libraries, and provides access to records of print and electronic materials as well as online forms and information about a variety of services.

The libraries at Duke are collaborating with other campus partners to create an open access digital archive of scholarly articles written by Duke faculty. Duke is granted a limited license to the final draft manuscript of all scholarly articles that faculty author and elect to place in the open access repository. This library-managed repository, DukeSpace, also provides electronic access to recent Duke dissertations and master’s projects as well as university records and other related digital content.

All Duke students and faculty have borrowing privileges at the libraries of North Carolina Central University, North Carolina State University, and the University of North Carolina at Chapel Hill. These reciprocal privileges are a benefit of the libraries’ membership in the Triangle Research Libraries Network, one of the oldest academic library consortia in the United States. The four TRLN library systems also cooperate in collection-building and preservation and the purchase of online databases and services. A recent TRLN innovation provides access to the holdings of all four member libraries with a single search of the online catalog.

Services Available to Graduate Students at Every Duke Library. The descriptions below are intended only as a general overview. Contact the library most convenient to you for more complete information about these and other services.

Checking out books and journals. Graduate students may borrow materials from any Duke library and return them to any campus library. Alternatively, they may also request that materials be delivered to any campus library they specify for convenient pick-up or return. However, the length of the circulation period for books and journals varies from library to library as do renewal policies.

Reserving materials for course use. Guidelines for reserving materials for class use as well as submission forms for books, e-reserves, and videos are available at http://library.duke.edu/research/reserves/reserves_guidelines.html. These guidelines apply at Perkins Library. Contact the Divinity Library, the Goodson Law Library, the Medical Center Library, and the Ford Library at Fuqua to reserve materials at those libraries for your classes.

Interlibrary Loan. The interlibrary loan service, offered at each campus library, obtains books, microforms, dissertations, journal articles, reports, and other materials not available on campus.

Reference/Research Assistance. Librarians at public service desks offer general and specialized assistance in the use of electronic and print sources and document retrieval. In addition to working with students and faculty at these desks, reference librarians also assist users via telephone, e-mail, chat reference, and IM. Chat reference assistance and IM are accessible from the libraries’ Web site at http://library.duke.edu/services/ask/.

Instructional Services and Resources for Classes and Labs. Librarians offer a range of services to instructors, including workshops, course-related Web pages, and subject guides. Details are available at http://www.lib.duke.edu/services/instruction/.

Assistance with innovative use of technology in teaching and other work with students. The Center for Instructional Technology, a division of the Perkins Library System, supports the university’s academic mission by helping instructors find innovative ways to use technology to achieve their teaching goals. For more information about the CIT and its activities, including Blackboard support, go to http://cit.duke.edu/.

Assistance with copyright and other scholarly communication issues. The university’s scholarly communications officer, a member of the libraries staff, is available to assist faculty and students regarding copyright use and ownership of digital and print material. For more information, contact Kevin Smith at Kevin.L.Smith@duke.edu.

Library Profiles

THE DIVINITY SCHOOL LIBRARY

The Divinity School Library serves the university with collections ranging across the entire spectrum of religions.
of the world. Areas of the collection in which particular strength has been built – in print, microform and electronic formats – include Biblical studies, Christian theology, American Christianity, Methodism, religious art and architecture, mysticism, and archaeology of the Near East. The library has significant and growing collections in Judaism, Islam, Hinduism, and Buddhism as well.

Materials selection reflects the curricular offerings of the Divinity School and the Department of Religion at both the undergraduate and graduate levels as well as supporting the research programs of the faculty of both divisions and doctoral candidates in the fields of religion and theology. The faculty is welcome to send purchase requests to the library director.

Information about the Divinity School Library, including circulation policies and reference and instructional services, may be obtained from the library staff or from the library’s Web site at http://library.duke.edu/divinity.

THE FORD LIBRARY AT THE FUQUA SCHOOL OF BUSINESS

The Ford Library houses the principal business collections for the university, comprising 30,000 print books and journals and a comprehensive collection of e-books and e-journals. The library also offers a comprehensive career collection and an extensive media collection, including audio books on a wide range of topics. In addition, the Ford Library offers the latest technology in online business information and over 50 databases for business research, which are available to Duke graduate students worldwide.

While the Ford Library’s collection is tailored to the curriculum strengths and research interests of the Fuqua School of Business, graduate students and researchers throughout the university are welcome to use library materials. Important areas of the collection are accounting, entrepreneurship, finance, health sector management, global business management, managerial economics, marketing, organizational behavior, and operations management. Recent acquisitions include key business issues in the curriculum, such as leadership, ethics, and the social responsibility of business.

Duke University graduate students have access to subscription databases from major business information producers such as Bloomberg, the Economist Intelligence Unit, Euromonitor, Factiva, Forrester, Frost & Sullivan, Hoovers, Lexis-Nexis, Marketline, Mintel, OneSource, ProQuest, Standard & Poors, and Thomson. These databases contain information on companies, industries, and other topics of interest to students and researchers. Access to these databases is available in libraries and computer labs throughout the university, as well as on individual laptops anywhere in the world 24/7.

Additional information about the Ford Library may be obtained from the library’s Web site at http://library.fuqua.duke.edu/index.html.

THE MEDICAL CENTER LIBRARY AND ARCHIVES (MCLA)

The Medical Center Library and Archives provides access to biomedical resources including more than 300,000 volumes of print books and bound journals as well as medical, nursing, and health sciences electronic journals and databases. The History of Medicine Collections house rare and unique materials as well as current publications that capture the history and development of medical practice. The Medical Center Archives collects and preserves the institutional records and history of Duke Medicine through faculty papers as well as administrative and departmental documents. MCLA’s collection supports Duke Medicine’s mission and programs, including those of the schools of medicine and nursing, Duke Hospital and Clinics, and the research enterprise. However, faculty, students, and staff across the university have access to these educational and research resources.

MCLA provides a variety of services to assist faculty and students in using biomedical resources. In addition to its traditional reference services, the MCLA offers in-depth consultations to assist our patrons with identifying the most relevant information resources, searching the literature, evaluating the results, and learning how to use specific databases and information tools. Education services include tours and orientations, drop in classes on the use of the library and customized training sessions for departments and schools. Evidence-based medicine training is also available for faculty, students, and clinical staff. Another popular service is our EndNote training.

The MCLA Web page is the virtual gateway for those seeking biomedical resources and services. The MCLA has developed specialized subject guides including clinical tools and nursing tools pages, online tutorials, and evidence-based medicine resources. The Web site http://www.mclibrary.duke.edu/ also provides more details about and links to library services.

THE J. MICHAEL GOODSON LAW LIBRARY

The Goodson Law Library, with over 640,000 volumes, is a resource for legal materials for both the university and the local legal community. It is a major research collection of legal literature that includes the primary sources of law along with a rich collection of texts, journals, and other materials that explain, analyze, and provide commentary on legal topics. An increasing number of electronic databases for both general and specialized legal research are available to all researchers in the Duke community.

Primary materials include reported decisions of federal and state courts, current and retrospective collections of federal and state codes, regulations, and session laws accessible electronically and in print. A full range of print and electronic indexes and other finding tools provide access to the primary sources. The periodical collection includes current and retrospective access to all major law journals, bar association publications, and institute proceedings. A
large portion of the library collection is devoted to treatises on all phases of law, and other social and behavioral sciences relevant to legal research. The library is a selective depository for United States government publications, with concentration on congressional, judicial, and administrative law materials.

In addition to its U.S. holdings, the library has substantial research collections in foreign and international law. The foreign law collection is extensive in coverage, with long-standing concentrations in European law and business law materials, and growing collections in Asian and Latin American law. The international law collection is strong in primary source and treatise material on both private and public international law topics.

The reference librarians are experienced legal researchers, holding dual degrees in law and library science, and can assist in all facets of legal research and library use. For contact information and initial research guidance visit the Goodson Law Library Web page at: http://www.law.duke.edu/lib/.

THE WILLIAM R. PERKINS LIBRARY SYSTEM

The Perkins Library and the adjoining Bostock Library and von der Heyden Pavilion form the university’s main library complex.

PhD candidates who have passed their preliminary examinations may apply for a library carrel by entering "carrel reservation list" as a title in the library’s online catalog and clicking the "get this title" link. Follow-up on reservation requests can be addressed to the staff at the Perkins circulations desk.

The library collections support the social sciences, humanities, biological and environmental sciences, chemistry, engineering, mathematics, physics, computer science, and astronomy/astrophysics and reflect Duke’s interdisciplinarity and international focus. There are extensive collections from and about East and South Asia, Latin America, Africa, Europe, and the United States as well as one of this country’s largest collections of Canadiana. Complementing the print collections are electronic resources, including tens of thousands of e-journals, databases, and statistical tools.

The library is a depository for United States, North Carolina, and European Community documents.

Subject librarians assist individuals (with book and journal requests, specialized research assistance, etc.) and serve as liaisons to academic departments and programs and the university’s interdisciplinary institutes and centers. For a listing of subject librarians, visit: http://library.duke.edu/about/directory/subject_librarians.html.

The library is creating unique digital collections along several themes including: advertising and consumer culture, documentary photography and film, Duke University history, and transcultural experience. The collections currently comprise about 115,000 objects. To browse the collections and related resources, visit: http://library.duke.edu/digitalcollections/.

The holdings of the Rare Book, Manuscript, and Special Collections Library (RBMSCL), located in the Perkins building, range from ancient papyri to the records of twentieth-century advertising. The collections support research in a wide variety of disciplines and programs, including African American studies, anthropology, classics, economics, history, literature, political science, religion, sociology, and women’s studies. Among the areas of particular strength are the history and culture of the U.S. South, English and American literature, history of economic theory, British and American Methodism, and the history of modern advertising.

The Duke University Archives, part of the RBMSCL, is the official repository for records of the university, collecting, preserving, and administering materials that have continuing administrative or historical value. Recently, working together with the Graduate School and other campus units, the University Archives launched DukeSpace, a digital repository providing access to electronically submitted Duke dissertations, master's papers, university records, and other related digital content. For more information, please see http://dukespace.lib.duke.edu/.

The Lilly Library on East Campus houses the university’s research collections for the visual arts, art history, philosophy, and theater studies plus Duke’s collection of more than 20,000 international and interdisciplinary feature films and documentaries and experimental and animated productions. Request videos for a classroom showing or place videos on reserve for the semester by submitting forms at http://library.duke.edu/lilly/film-video/reserve-form.html. Please allow three (3) working days for the processing of your request.

The Music Library and Music Media Center, also on East Campus, have a rapidly expanding collection of music scores, books, journals, and music-related media, encompassing more than 18,000 CDs, thousands of LPs, and hundreds of DVDs and VHS recordings. The music collection supports teaching and research in musicology, historical performance practice, and composition. Additional strengths include keyboard music (monographs as well as scores), music and art, and musical instruments.

One additional Perkins System library, the Pearse Memorial Library, is located in Beaufort, North Carolina, at the Duke Marine Laboratory. Its holdings are in marine sciences and policy-related aspects of the marine environment.

The Office of Information Technology

The Office of Information Technology strives to enhance teaching, learning, and research at the university by providing information technology resources that are easy to use and well-matched to the needs of faculty, staff, and students. OIT is responsible for:

- electronic identity management (your Duke "NetID" and password), which allows access to Duke systems
- personal computing services (e-mail, calendaring, and instant messaging)
• personal and large-scale computing services, as well as virtual computing environments
• Duke's wired and wireless networks
• voice communication (wired phones and mobile phones)
• cable TV services
• mobile computing applications
• support for the use of multimedia in teaching, in cooperation with the Duke Center for Instructional Technology
• Web design services

You'll find most everything you need to know about technology at Duke on the OIT Web site: http://www.oit.duke.edu, and on the special pages designed to support new members of the Duke community: http://www.oit.duke.edu/newtoduke. To get help with information technology resources at any time, contact the OIT Service Desk: http://www.oit.duke.edu/help/index.php or walk up to the Service Desk at The Link in the basement of Perkins Library.

There are many other IT organizations and support groups across campus. We encourage you to familiarize yourself with some of these sites:

**Enterprise-wide IT Organizations**

- Health System:
  - Duke Health Technology Services (DHTS) http://dhts.duke.edu/
  - DHTS Web Services http://webservices.dhts.duke.edu/modules/flash_articles/
- Blackwell Interactive (Web services) http://www.blackwell.duke.edu/
- Information Technology Advisory Council http://www.oit.duke.edu/itac/index.html

**Academic Technology Support**

- Center for Instructional Technology (CIT) http://cit.duke.edu/
- Duke Digital Initiative (DDI) http://dukedigitalinitiative.duke.edu/

**School-based IT Support**

- Duke University Divinity School http://library.duke.edu/divinity/help/compfaq.html
- Duke University School of Law http://www.law.duke.edu/computing/
- Duke University School of Nursing http://nursing.duke.edu/modules/son_currentstudents/index.php?id=3
- Fuqua School of Business http://it.fuqua.duke.edu/index_jump.html
- Nicholas School of the Environment http://www.env.duke.edu/it/
- Trinity College of Arts & Sciences Office of Technology Services http://trinity.duke.edu/technology

**Science Laboratories**

**Biological Laboratories.** Facilities for graduate study in the Department of Biology are located on the West Campus, together with those of supporting departments (physics, chemistry, earth and ocean sciences, and the basic medical sciences). Scientists in plant and animal biology with common interests are clustered in two buildings: the Biological Sciences Building, and the French Family Science Center. The two buildings are physically connected and maximal interaction occurs between the different groups in biology through seminars, shared instrumentation and collaborative research projects. Special facilities include the IGSP DNA sequencing facility, animal rooms, greenhouses, refrigerated and controlled environment rooms, access to environmental scanning electron microscopes, confocal microscopes, Model Systems Genomics computer support and facilities, a stable isotope mass spectrometry laboratory, and other modern research facilities. Extensive facilities for experimentation in environmental control of plant growth are available in the Phytotron adjacent to the greenhouses.

The herbarium contains approximately 700,000 specimens and includes notable collections of mosses and lichens. Other assets for teaching and research are the Sarah P. Duke Gardens on the West Campus; the eleven-acre experimental plot and field laboratory; the Duke Forest, comprising 7,900 acres of woodland adjacent to the West Campus; the field station for the study of ecology; and the Nicholas School’s Marine Laboratory, an interdepartmental facility located on a small island on the coast at Beaufort, North Carolina, where twenty-two buildings and a small flotilla of ships and boats provide teaching and research facilities for resident graduate students and faculty as well as visiting individuals or groups.

Duke University, through the Department of Biology, is a member institution of the Organization for Tropical Studies, Inc., a consortium of universities with field station facilities in Costa Rica that provide opportunities for course work and research in tropical science.
Highlands Biological Station. Duke University holds a contributing membership in the Highlands Biological Station at Highlands, North Carolina, on the southern edge of the Blue Ridge Mountains at an elevation of 4,118 feet. The station and the region offer an excellent opportunity for field studies and some laboratory work. A limited number of qualified students in biology may make arrangements to carry out research here. Scholarships for advanced study during the summer months are available through the station.

The Plant Teaching and Research Complex. Managed by Duke Biology, The Plant Teaching and Research Complex is the core support facility for researchers using plants in the instructional and research programs for Duke University. It plays an important role in supporting the university’s objective through research, teaching, and extension.

The Plant Teaching and Research Complex is comprised of three separate facilities: The Phytotron, The Research Greenhouse, and the Teaching Collection. These facilities are dedicated to Duke University researchers and instructors.

The Phytotron. The Phytotron houses 44 growth chambers of varying sizes and six greenhouse units. Environmental factors controlled in these units include light, temperature, nutrients, carbon dioxide concentration, and humidity. Founded in 1968, the facility has a long and distinguished history of plant-controlled environment research, and is an important tool for global change research. It supports studies ranging from individual plant to whole ecosystem responses to changes in atmospheric carbon dioxide levels and/or temperatures. The facility boasts a dedicated staff with many years of experience in controlled environment research.

Research Greenhouse. The Research Greenhouse, built in 2004, is equipped with some of the latest technology in greenhouse-controlled space. The total facility spans 12,676 square feet. This space encompasses eight growing zones separated by airlocks, and a propagation room. Growing zones are designed to stay within a three-degree set point.

Teaching Collection. (Temporarily housed in the Research Greenhouse.) Considered one of Duke’s hidden gems, this diverse reference of plants is used for both research and teaching. The collection features over 1,500 labeled species hosting a variety of interesting and important genera, including aquatic, desert, tropical, temperate, rare, and endangered species. The primary function of the plant teaching collection is to serve undergraduate teaching at Duke University. Because of its uniqueness, this group also serves as a resource for world-renowned botanists as well as local school groups. In addition, we protect species on the list of rare or threatened plants by vouchering plants to other universities. For tours please contact Marcia Kirinus.

For more information on this complex, please contact Marcia Kirinus, Managerial Director or visit our Web site: http://www.biology.duke.edu/plantfacility/.

Duke Forest. The Duke Forest comprises over 7,000 acres of land in Durham, Orange and Alamance counties and has been managed for research and teaching purposes since 1931. The mission of the Forest is to facilitate research that addresses fundamental and applied questions concerning forested and aquatic ecosystems and to aid in the instruction of students so that they will be informed citizens and effective stewards of our natural resources.

The Forest lies primary near the eastern edge of the piedmont plateau and supports a cross section of the woodlands found in the upper coastal plain and lower piedmont of the Southeast. A variety of timber types, plant species, soils, topography, and past land use conditions are represented. Elevations range from 260 to 760 feet above sea level. Soils of the region are derived from such diverse parent materials as metamorphic rock of the Carolina Slate formation, granite, Triassic sedimentary rock, and basic intrusives.

Academic use of the Duke Forest ranges from class instruction to long-term research projects, including studies on such diverse topics as vegetation composition, landscape ecology, remote sensing, invertebrate zoology, atmospheric science, and global climate change. Background information useful to research covers such features as soils, topography, forest inventory, plantation and cultural records, as well as a bibliography of past and current studies. Much of this data is available electronically in Geographic Information System (GIS) format.

In addition to leading educational tours and field laboratory exercises, Duke Forest staff are available to assist researchers in site establishment and management. Researchers can request forest stand manipulations, such as thinning and prescribed burning. Staff can also assist in preparing field areas through mowing, disking or planting with in-house equipment. Location of study areas can be mapped using our Global Positioning System (GPS) unit.

All graduate students who wish to initiate research or lead class activities in the Duke Forest should contact either Judson Edeburn, Resource Manager, or Marissa Hartzler, Program Director (see contact information below) to discuss the project. Through a simple registration process, students can gain access to all of the Forest’s services, including maps and gate keys (for a $10 deposit).

Contact: Office of the Duke Forest, Duke University, Room 412, North Building; phone 919-613-8013; Judson Edeburn, Resource Manager, e-mail: judeburn@duke.edu; Marissa Hartzler, Program Director, e-mail: mlm27@duke.edu; Web site: http://www.dukeforest.duke.edu.

Morphodynamics and Coastal Processes Simulation Lab. Dr. Brad Murray’s lab includes Silicon Graphics and LINUX computers, as well as PCs, and access to a large number of processors in a computing cluster in Colorado. Along with students, postdocs, undergraduate assistants, and visiting scholars, Murray uses these machines chiefly for developing and running numerical models of Earth surface processes. Experiments with relatively simple models address the evolution and response to climate change of an array of environments, including sandy and rocky coastlines,
nearshore seabeds, coastal marshes, surf zones, rivers, deltas, desert sand dunes, arid landscapes, and patterned arctic permafrost. Interactions between physical landscape forming processes and biological processes, including humans, take center stage in several of these efforts. Field observations play a key role in motivating and testing these theoretical investigations, and the lab includes equipment to facilitate observations, including a basic GPS unit, video collection and analysis hardware and software, and a high-powered PC for processing large remote sensing (e.g. LIDAR) data sets.

**Petrology Laboratory.** The laboratory space of Dr. Boudreau is used largely for general rock sample preparation by members of the petrology/geochemistry group, and includes the following equipment: separatory funnels for mineral separations using the heavy liquids; small sample crushing and sieving equipment; precision diamond wafering blade rock cutting equipment; thin section polishing laps for polished sections for petrographic and electron microprobe study; small Deltech experimental 1 atmosphere high temperature furnace, used for making electron microprobe standards and for high temperature experiments; rock tumbling equipment for aggrading mineral separates; acid dissolutions that are not standard as are used for ICP-MS analysis. An example includes perchloric acid dissolutions, for which the OSHA-required wash down hood in the lab is the only one in the division.

**Electron Microprobe Laboratory.** The electron microprobe lab, directed by Dr. Alan Boudreau, is used by the petrology and geochemistry groups at Duke and UNC. As such, it is an indispensable basic tool in mineral analyses. The machine consists of a Cameca CAMEBAX (French manufacture) electron microprobe with 4 wavelength-dispersive spectrometers, an energy dispersive spectrometer and digital electron microbeam imaging system. It is automated with control through an Apple Macintosh operating system. The lab is part of a Duke-UNC shared laboratory facilities agreement.

**Geochem Laboratory.** Dr. Paul Baker’s lab has all facilities necessary for major and minor wet chemical analysis. This includes an atomic absorption spectrophotometer, an ion chromatograph, a UV-Vis spectrometer, and a Phillips X-Ray diffractometer. Dr. Baker’s lab also has field sampling equipment including seismic reflection profilers and a variety of coring equipment for undertaking marine and fresh water sediment and water column sampling.

**Micropaleontology Laboratory.** Dr. Bruce Corliss has a micropaleontology laboratory which is set up to process marine sediments for the analysis of microfossils. Corliss also maintains an 8x10’ environmental room, which is temperature controlled and used for culturing of deep-sea organisms.

**High Temperature Chemistry/Petrology Laboratories.** Instruments and laboratory facilities overseen by Dr. Emily Klein within the high-temperature chemistry/petrology group include the following instruments and laboratory equipment for sample preparation. 1) ARL-Fisons Spectraspan 7 direct current plasma (DCP) spectrometer was purchased in 1993 through a grant to NSF Ocean Sciences submitted by Emily Klein, with matching funds provided by Duke. It is equipped with a 24 channel multi-element cassette for major- and high-abundance trace-element analysis for elements and high abundance trace elements (to ppm levels). 2) VG PlasmaQuad-3 inductively-coupled-plasma mass-spectrometer (ICP-MS) is equipped with the S-option pump for increased sensitivity and a UV laser-ablation microprobe for spot analyzes to 6 microns (for ultra-trace-element spot analyzes in the ppb levels). Detection with peak:blank ratios of better than 3:1 has been demonstrated down to 1 ppt or better for heavier elements (mass greater than 80) and 5 ppt for most lighter elements. This instrument is commonly used for the bulk analysis of low abundance trace elements including the rare earth elements, high field strength elements and a wide range of other elements.

**The Thermal Ionization Mass Spectrometer (TIMS) Lab** ([http://www.nicholas.duke.edu/tims](http://www.nicholas.duke.edu/tims)). Dr. Avner Vengosh oversees this laboratory, housed in the Division of Earth and Ocean Sciences at the Nicholas School of Environment in Duke University. The heart of the lab is a fully automated Thermo Scientific TRITON thermal ionization mass spectrometer (TIMS). The TRITON is a new thermal ionization mass spectrometer with the most precise and accurate isotope ratios for positive and negative ions (see at Web site: [http://www.thermo.com/com/cda/product/detail/1,1055,12080,00.html](http://www.thermo.com/com/cda/product/detail/1,1055,12080,00.html)). The instrument was installed in February 2008. Currently we have developed the analytical procedures for boron and strontium isotopes.

**The Laboratory for Environmental Analysis of RadioNuclides** ([http://www.nicholas.duke.edu/learn/](http://www.nicholas.duke.edu/learn/)). Dr. Avner Vengosh oversees this laboratory, which includes:

- Two scintillation alpha counters (made by Scientific Computer Instruments, West Columbia, SC) for measuring low abundances of $^{224}$Ra and $^{223}$Ra activities (Moore and Arnold, 1996; Vinson et al., in press)
- Canberra high resolution Broad Energy germanium (BEGe) detector (BE5030) gamma spectrometry with 50% relative efficiency equipped with ultra low background hardware, an In Situ Object Counting System (ISOCS), mathematical calibration software, and Genie 2000 Multi-Input software. The instrument is currently calibrated for measurements of $^{226}$Ra, $^{228}$Ra, $^{210}$Pb, and $^{137}$Cs radionuclides.
- RAD7 Electronic Radon Monitor/Sniffer for accurate measurements of radon in air and water, made by Durridge Company Inc., MA, USA. The instrument is calibrated for measurement of $^{226}$Ra in Mn-fibers after three-weeks incubation.

**Forestry Sciences Laboratory.** The Forestry Sciences Laboratory of the USDA Forest Service, Southeastern Forest Experiment Station is located in the Research Triangle Park near Durham. This research organization provides...
excellent opportunities to complement research conducted by students in the Nicholas School of the Environment and Earth Sciences. Specialized research projects in forest economics, carbon cycling, and productivity are currently underway at the laboratory. The staff of the laboratory is available for consultation and participation in seminars. Arrangements may be made for students to conduct certain aspects of their research at the laboratory.

**Marine Laboratory.** The Duke University Marine Laboratory (DUML) of the Nicholas School of the Environment is an educational and research facility. DUML is located on Pivers Island, within the Outer Banks, adjacent to the historic seacoast town of Beaufort, North Carolina, with direct access to the Atlantic Ocean, Cape Lookout National Seashore Park, estuaries, sand beaches, wetlands, and coastal forests. The area provides an excellent opportunity for teaching and research at the undergraduate, masters, and doctoral levels. There are approximately 30 masters and 30 resident doctoral students. (For additional information concerning the MA, MS, and PhD graduate programs refer to the section "Courses and Academic Programs" in this bulletin and for the Master of Environmental Management graduate program refer to the current Bulletin of Duke University: Nicholas School of the Environment.) The Marine Laboratory accommodates nearly 3,700 visitors per year. The physical plant consists of 23 buildings including five research buildings, six dormitories, a dining hall, classroom laboratories, student center, and a maintenance complex. Research from the molecular to the population level is supported at the Marine Laboratory. DUML operates the R/V Susan Hudson, a 57-foot fully equipped coastal oceans research vessel with the capacity to perform small-scale biological, chemical, geological, and physical oceanography. DUML is also the home port for the R/V Cape Hatteras, a 135-foot oceanographic research vessel operated for the NSF by the Duke/University of North Carolina Oceanographic Consortium.

For information concerning teaching and research space, write to Auxiliaries Services, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721; telephone 252/504-7652 or e-mail: dominick.brugnolotti@duke.edu.

**Lemur Center.** The Duke Lemur Center is located in Duke Forest about two miles from the main campus. It is the world’s only facility devoted entirely to the care, conservation, and study of lemurs. The colony is composed of approximately 250 animals from more than twenty named taxa. The lemurs, and their closest relatives, the lorises, are housed in spacious indoor and outdoor facilities. In the summer months in particular, numerous lemurs "free range" in large tracts of open area within Duke Forest, providing a unique opportunity for investigators and students to study lemur behavior in a semi-natural setting. The Center also houses frozen, preserved, and fossil primate collections for study. All collections are utilized by students and faculty from a wide variety of Duke departments, as well as by scholars from other national and international institutions. Graduate students wishing to conduct research at the Center should indentify this interest to the director of graduate studies for the department to which they are applying. For information pertaining to the use of the Lemur Center, graduate studies, or availability of research space, write to Dr. Sarah Zehr, sz19@duke.edu, Research Manager, Duke Lemur Center, 3705 Erwin Road, Durham, North Carolina 27705.

**Chemistry Laboratories.** In 2007, the Department of Chemistry moved to the French Family Science Center, a state of the art research facility donated by Bill and Melinda Gates. This building houses not only the entire Chemistry Department, but also Biological Sciences, and a portion of the Physics Department and research labs. The building contains 275,000 square feet of total area, with additional research space in the Levine Science Research Center to accommodate chemistry at the biology interface. This well-equipped chemical laboratory provides conditions conducive to research in many areas of current interest. Major shared instruments, including those for nuclear magnetic resonance and mass spectrometry, are housed in the departmental instrumentation facility, along with optical and other instrumentation, including FTIR, UVVIS, and fluorescence spectrometers. A wide array of more specialized instrumentation is available in the various research laboratories, from ultrafast laser systems to atomic force microscopes to automated solid-phase synthesizers. Other major facilities on campus include the Free Electron Laser Laboratory and the University NMR Center, which maintains several ultra high field NMR instruments. A broad range of instrumentation for biological and materials science applications is accessible in the Medical Center and School of Engineering, with additional facilities available at the neighboring universities and in Research Triangle Park, including those for x-ray diffraction and structure determination.

Computing facilities in Chemistry include SGI and Redhat Linux workstations, Beowulf clusters, and clusters of PC's associated with the teaching laboratories. The department is linked to the university's high speed fiber optic network and to the university’s high performance shared computing cluster. This building is primarily a research facility, and the majority of space is dedicated to research and teaching labs. In addition, the department has state-of-the-art computer/video projection systems in its lecture hall and conference rooms and wireless networking for incorporation of the latest computational research tools into the undergraduate chemistry curriculum.

**Physics Laboratories.** The Physics Building houses research and instruction in the Department of Physics and Mathematics. Additional space is provided by the adjacent Nuclear Building (TUNL) and French Family Sciences Free Electron Laser (FEL) Laboratory Buildings. Graduate students conducting research in these buildings usually have their offices there.

About half of the Physics space is devoted to research laboratories for the department's programs. Special equipment includes: ultrafast, high power, short wavelength, and far-infrared lasers; a 1 GeV linear accelerator and high current electron storage ring driving an ultraviolet to soft X-ray FEL (this facility is used, among other things, to
produce a high-intensity gamma-ray source known as the HIGS project); a high-resolution 4 MeV Van de Graaff accelerator; a 20 MeV tandem Van de Graaff accelerator with polarized source and cryogenically-cooled polarized targets; cryostats, superconducting magnets, and associated equipment for research in condensed matter physics; a scanning electron microscope with electron beam lithographic capability and other materials processing equipment is housed in the Shared Materials Instrumentation Facility (SMIF); several computers for data collection and processing in all of the research groups; a massively parallel computer system for particle, nuclear, and condensed matter theory; desktop computers are typically provided for all grad students.

The Physics Building is located near Bostock Library, which contains a large selection of books and scholarly periodicals. Located in the Physics Building are an appropriately staffed instrument shop and information technology support staff.

Engineering Research Laboratories. The laboratories of the four departments of the Pratt School of Engineering contain extensive state-of-the-art equipment that may be used in several specialized fields. With the Fall 2004 opening of the Fitzpatrick Center for Interdisciplinary Engineering, Medicine and Applied Science (FCIEMAS), an extensive new infrastructure exists for interdisciplinary laboratory and teaching activities. Departmental facilities already present in Hudson Hall are now complemented by extensive new infrastructure facilitating interaction involving all Pratt departments and research centers and also working in close proximity to units from medicine and the sciences. Facilities available for instruction and research are suggested by the following representative listing of equipment found in each department:

Biomedical Engineering. Biomechanics laboratories: hydraulic testing system, IBM PS/2 microcomputer, micro VAX II computer, optical displacement measuring system, silicon graphics/GE graphcon system, Sun micro systems SPARC station, Zonic modal analyzer. Biomedical materials and surface interactions laboratories: air- and water-cooled Argon lasers, air convection oven, capillary rheometer, FTIR infrared spectrometer, gamma counter, gel permeation chromatograph, Langmuir-Blodgett trough, liquid nitrogen cooled CCD camera, Nikon inverted microscope with phase contrast and epifluorescency. Ultrasound imaging and transducer laboratories; CAD/CAM stations for circuit development, diamond tip dicing saw, high-speed video system, image processing system, laminar flow hood, multiple PCs and work station, PC board maker, ultrasound mechanical scanner, VAX 11/780.

Civil and Environmental Engineering. Faculty in Civil and Environmental Engineering routinely design, construct, and adapt laboratory equipment for specialized teaching and research tasks in engineering mechanics, environmental engineering, geomechanics, structural engineering, and water resources engineering. In addition, arrays of standard laboratory facilities are available to support each research area.

Research and teaching facilities in engineering mechanics, structural engineering, and geomechanics include four independent closed-loop electrohydraulic dynamic loading systems (MTS), with a frequency range up to 100 Hz, and ranges of load to capacity 6,000, 35,000, 50,000 and 220,000 lbs. The 6,000 lbs. actuator can develop a constant crosshead speed up to 50,000 in./min. For teaching and research, the department has a 10,000 lb. universal testing machine and a 10,000 lb. torsion machine both fully instrumented with computer data storage, as well as a Kistler force plate with 10 decades of sensitivity. Equipment is available for fabricating specimens and testing fiber-reinforced polymer composites. An environmental chamber tests in the temperature range of -100º to +350º F; equipment for spectral and modal dynamic analysis, and an ultra-high pressure triaxial shear apparatus is available for confining pressures up to 100,000 psi. Rock-testing facilities, model-testing equipment for anchored walls and penetrometer studies, a large-aperture research polariscope, a reflective photoelastic polariscope, and a sustained-loading facility for long duration in studies of prestressed concrete are routinely used in teaching and research procedures.

Research and teaching facilities in environmental engineering include wet and dry laboratories equipped to study a range of physical, chemical, and biological processes. A fully integrated resource recovery pilot plant, calorimetry for the measurement of heat values of secondary fuels, air classifiers interfaced with computer monitors, as well as indoor and outdoor water resources monitoring devices including flumes, Venturi meters, and digital computation hardware are available. The biotechnology and physical-chemical laboratories are equipped with autoclaves, a media preparation room, walk-in environmental rooms, numerous fume hoods, a biohazard containment facility for cultivation of genetically engineered microorganisms, fully instrumented bioreactors with online control, and various analytical instrumentation including liquid scintillation counting, autoradiography, atomic adsorption spectroscopy, total carbon analysis to ppb levels, gas chromatographs equipped with ECO, FID, and TCD detectors, HPLC’s, computer-assisted image analysis microscopes, and a recently acquired fourier transfer infrared spectrometer facility.

Computer resources available to Civil and Environmental Engineering students include a multitude of personal computers distributed through departmental research facilities. Additionally, the department houses and maintains its own computing facility, providing UNIX workstations and IBM-compatible PC’s. This particular facility is dedicated to graduate student research and special undergraduate projects. Most of the computer resources are networked with the Pratt School of Engineering’s ethernet backbone and are easily accessible from several locations in the department and across the campus. Depending on the specific application, students can successfully investigate
problems in computational fluid and solid mechanics, rigid-body dynamics, particle and mathematical optimization as well as transportation and environmental systems engineering research topics. Several BEOWOLF computing clusters are housed in the department. Many problems addressed by the faculty and students of the Department of Civil and Environmental Engineering are computationally complex and could not be approached without the substantial computing facilities available at Duke.

Electrical and Computer Engineering. General computing laboratory equipped with several IBM RS-6000s servers and a fast interconnect network in a UNIX environment for interactive design, graphics, computation, and computer-aided engineering; Sun SPARC workstations for VLSI design; ethernet network for connection to regional, national, and international data networks; Signal Processing Laboratory with Sun workstations; microwave facilities for experimentation up to 35 GHz; robotics with a GE P-50 robot; microprocessor laboratory; Digital Systems Laboratory; solid-state power conditioning laboratories with dedicated computers for controlling instruments, including digital processing oscilloscopes and network and impedance analyzers, and for computer-aided design; clean room and semiconductor nMOS fabrication laboratory for integrated circuits; a molecular beam epitaxy laboratory for III-V compound semiconductor crystal growth using a Riber Model 3R&D MBE system; access to the design, fabrication, and research facilities of the Microelectronics Center of North Carolina; and an ion implanter and MOCVD epitaxial growth system in a III-V compound semiconductor lab at the Research Triangle Institute.

Mechanical Engineering and Materials Science. The department has a number of well-equipped laboratories for studies in aerodynamics, acoustics, nonlinear dynamics and chaos, microscale and convective heat transfer, computational fluid mechanics and heat transfer, control theory, cell and membrane biomechanics, bioreheology, polymer engineering, corrosion, electronic materials, physical metallurgy, positron annihilation spectroscopy, and expert systems. Equipment in these laboratories includes a wind tunnel, several scanning electron microscopes and scanning tunneling microscopes, doppler broadening and lifetime positron systems, a liquid helium cryostat, DSC/DMA facilities and diffusion furnace, inverted microscopes, low-light-level video cameras and a photon counter, cell-culture systems, an anechoic chamber, dynamic signal analyzers and laser velocimeters for dynamic analysis, an X-ray generator and diffractometer, FTIR spectrometer, high-power lasers with lock-in amplifier, and fluorescence microscopes.

The Duke Hypo-Hyperbaric Center is a major center for research, treatment and training involving hyperbaric and hypobaric exposure and simulation. The facility includes the F. G. Hall Laboratory, a large multi-chamber complex, and supporting clinical and laboratory services. Hyperbaric oxygen is used in the treatment of many disorders, including decompression illness, gas gangrene, carbon monoxide poisoning and wound healing. The hyperbaric facility is fully equipped with state-of-the-art hemodynamic and blood gas monitoring equipment, allowing uninterrupted delivery of critical care for patients requiring intermittent hyperbaric oxygen therapy.

As the major facility in the Southeastern U.S. for the referral and treatment of serious diving accidents and air embolism cases and for patients with hypoxic and non-healing conditions for which hyperbaric oxygen is used, the laboratory provides wide opportunities for scientific, clinical, and research training for graduate students, postdoctoral fellows, and physicians in high and low pressure-related medicine and physiology. The Center faculty also consult on recreational diving illness for the National Diver’s Alert Network (DAN) and Dive Assure. The program is interdisciplinary with major participation by the Departments of Anesthesiology, Medicine, Surgery, Cell Biology, Neurobiology, and the Pratt School of Engineering.

The Medical Center. Currently the Medical Center at Duke University occupies approximately 140 acres on the West Campus. The southern quadrant is contiguous with the main quadrangle of the university and consists of the following: Davison Building, Duke Hospital South, Baker House, Barnes Woodhall Building, Diagnostic and Treatment Building, Ewald W. Busse Building, Eugene A. Stead Building, Clinical Research II, and the Edwin A. Morris Clinical Cancer Research Building.

The northern portion includes the Joseph and Kathleen Bryan Research Building for Neurobiology, Nanaline H. Duke Medical Sciences Building, Alex H. Sands Medical Sciences Building, Edwin L. Jones Basic Cancer Research Building, Clinical and Research Laboratory Building, Bell Building, Seeley G. Mudd Communications Center and Library, Joseph A. C. Wadsworth Building (Eye Center), Duke Hospital North Division and Anlyan Tower, and Lenox Baker Hospital.

In the eastern section of the campus are Pickens Rehabilitation Center, Civitan Mental Retardation and Child Development Center, and Trent Drive Hall. In the western section of the campus are: Surgical Oncology Research Building; Environmental Safety Building; Research Park Buildings I, II, III, and IV; the Vivarium; and the Cancer Center Isolation Facility.
Student Life

Living Accommodations

Duke offers a residential apartment facility in which graduate and professional students live. The apartments are within short walking distance of university bus service. All apartments are air-conditioned, fully furnished, and utilities (heating/cooling, electricity, water, internet) are included. The complex has a swimming pool for residents’ use. Licenses to occupy space in these facilities are issued for the academic year. For more information, please contact Residence Life and Housing Services at housing@studentaffairs.duke.edu.

Requests for Duke University housing may be submitted after you have been admitted and have returned the official acceptance form. Students may apply online at http://www.studentaffairs.duke.edu/rhs. Space is limited, and all students who intend to request housing are encouraged to apply early. In recognition of the special needs of newly accepted international students, priority for assignment to graduate and professional student housing will be awarded to those students arriving from abroad on student visa status.

Duke Community Housing is an off-campus rental housing resource for graduate students. Staff members are available to answer questions concerning housing needs and maintain a database of rental properties, accessible via the Internet at http://www.studentaffairs.duke.edu/communityhousing. For more information, contact Duke Community Housing at (919) 684-6711 or e-mail: communityhousing@duke.edu.

Dining Services

Graduate students are welcome to dine on campus at any Duke Dining Services facility. Dining Services provides cafeterias, ethnic and fast food restaurants, delis, snack bars, bagel shops, authentic Kosher food, and a juice bar at the Wilson Recreational Facility on West Campus. The unique campus restaurants and cafés offer options sure to satisfy your taste preferences. A complete and up to date list of dining options offered by Duke Dining Services is available online at: http://dining.duke.edu/where/oncampus/index.php

On West Campus, dine at The Great Hall (West Union Building), a food court offering a great deal of variety in one location. The Loop Pizza Grill (West Union Building) offers gourmet salads, California- and Chicago-style pizza, and burgers. Subway serves submarine sandwiches and Edy’s ice cream. Pauly Dogs (located on the plaza outside the Loop) offers hot dogs, soft drinks, and assorted snacks. Chick-fil-A (West Union Building) offers the traditional menu served at Chick-fil-A restaurants, in addition to burritos made by The Cosmic Cantina. Alpine Bagels & Brews (West Union Building) and The Alpine Atrium, (Bryan Center) offer bagels, assorted coffees, fresh-squeezed orange juice, smoothies and salads/desserts. Panda Express (Bryan Center) is open daily serving traditional Chinese favorites. The Armadillo Grill (Bryan Center) offers a wide variety of Tex-Mex options. Our 24-hour McDonald's (Bryan Center) features a full menu for breakfast, lunch and dinner. We also have operations in the Law School (the Refectory at Duke Law) that offer hot, healthy, homemade breakfast and lunch including fresh burgers. In the Sanford Institute for Public Policy the Sanford Deli offers a typical deli-style menu. Tommy’s and The Bella Union (McClendon Tower in Keohane Quad): Tommy’s, Duke’s own Q-Shack, serves BBQ, ribs, and other southern favorites. The Bella Union serves coffee, assorted hot and cold beverages, pastries and ice cream. Quenchers Juice Bar (Wilson Center) offers refreshing smoothies, energy drinks, and fresh fruit to complement your healthy lifestyle. Saladelia at The Perk (Bostock Library) is a traditional coffee bar offering a wide variety of coffees, sandwiches and pastries. The Terrace Café (Duke Gardens) serves hot and cold beverages, sandwiches, salads, and gourmet desserts.

On East Campus, visit The Marketplace (East Union Building), and select from a wide variety of choices including pasta, pizza, deli, rotisserie, grill and salad bar stations. Trinity Café (East Union Building) has a diverse selection of quality coffees, pastries, salads and snacks.

On North Campus (Trent), Grace’s Café offers a variety of American and authentic Chinese cuisine. Our newest location, Devil’s Bistro, is located on Central Campus and features omelets, soups, salads, brick-oven pizzas, in addition to a coffee and wine/beer bar.

On Research Drive, Blue Express (Levine Science Research Center) offers hot and cold sandwiches and entrees, snacks, desserts and drinks. Twinnie’s (Ciemas-Pratt), our Irish Pub, offers gourmet salads, sandwiches, and beer on tap. Dolce Vita (French Science Center) is the perfect spot for a quick bite and cup of coffee.

Food purchases may be made in one of three ways: cash, a dining account (food points), or a flexible spending account. The dining and flexible spending accounts are the preferred tender methods, as they allow students to make purchases on campus by accessing a prepaid account carried on the student identification card, or DukeCard.

Further information about campus dining facilities and dining plan options is available from Duke Dining Services, 029 West Union Building, Box 90898, Durham, NC 27708-0898, (919) 660-3900. Stay up to date with the latest in Dining news by visiting our Web site, http://dining.duke.edu/. We look forward to serving your dining needs soon!

Services Available

Student Disability Access Office. Duke University is prepared to make reasonable academic adjustments and accommodations to allow students with disabilities full participation in the same programs and activities available to students without disabilities. The Student Disability Access Office (SDAO) assists students who are enrolled in the Graduate School. In order to receive consideration for reasonable accommodations under the Americans with Disabilities Act (ADA) of 1990 and ADA Amendments Act of 2008, a student must have a physical or mental impairment that substantially limits one or more major life activities. Substantially limited refers to an impairment that prevents an individual from performing major life activities or significantly restricts the condition, manner, or duration under which an average person can perform a major life activity.

Students requesting accommodations under the provisions of the ADA and ADA Amendments Act of 2008 (academic, housing, etc.) must contact the Director of the Student Disability Access Office at (919) 668-1267 or (919) 668-1329 (TTY) to explore possible coverage. Receiving accommodations or special assistance in high school, at another college or university or from a testing agency does not necessarily qualify an individual for the same accommodations and/or assistance at Duke University.

The vice-president for Institutional Equity is the designated compliance officer for the ADA, ADA Amendments Act of 2008, and the Rehabilitation Act of 1973. The compliance officer can be reached at (919) 684-2222.

Student Health Services. Student Health Services (SHS) at Duke University is a joint program supported by the Division of Student Affairs and the Department of Pediatrics. A wide variety of services are available through SHS.

Student Health Center. The Student Health Center (SHC) is the primary location for healthcare services including general medical care, nutrition counseling, laboratory, pharmacy, travel and immunization clinics, and allergy/immunotherapy clinic. Most services are covered by the Student Health Fee (see below). Radiology studies, prescription drugs, most laboratory tests, and all specialty services received at the SHC are not covered by the Fee. The SHC is located on Flowers Drive in the Duke Clinic complex (Duke South, sub-basement, Orange Zone). Medical services are provided by board-certified faculty physicians and by physician assistants, nurse practitioners, and resident physicians under faculty supervision. Students are seen by appointment, (919) 681-WELL, M,T, Th,F from 8:30 a.m. to 5:00 p.m. and W from 9:30 a.m. to 5:00 p.m. Limited walk-in services are also available on a daily basis. An Acute Care Clinic is held on weekends. Nurse advice is available at all hours when the SHC is closed (919-966-3820). See http://www.studentaffairs.duke.edu/studenthealth for more information.

Students are encouraged to use the Student Health Center as their portal of entry to other health resources, including the specialty clinics within the general community and Duke University Health System. This helps with coordination of care. In the event of a life-threatening emergency, students should go directly to the Emergency Department. If necessary, Duke Police (911 or (919) 684-2444) provides on-campus transportation to the Emergency Department.

Health Promotion. Health Promotion staff are available to assist students in making informed decisions that promote their health. Topics include fitness assessment, alcohol and other drug usage, eating and body image concerns, sexual activity and sexually transmitted diseases, stress management, and others. See the Healthy Devil Online at http://www.studentaffairs.duke.edu/duwell for more information.

Student Health Physical Therapy. The Student Health Physical Therapy Consultation Service is located in the Student Health Center. A physical therapist is available weekdays when undergraduate classes are in session. Students are seen by appointment to assess exercise-related problems and to outline short-term treatment plans, aid recovery, and help prevent re-injury. For more comprehensive physical therapy, students are referred to local consultants.

Confidentiality. Information regarding the physical or mental health of students is confidential and is released only with the student's permission except in life-threatening circumstances. As a member of the Duke University Health System, the Student Health Center is fully compliant with HIPAA federal regulations.

Student Health Fee. All currently enrolled full-time students and part-time degree candidates are assessed a mandatory Student Health Fee each semester. This covers most services delivered within Student Health. Students not enrolled in the University for medical, judicial, or personal reasons are not eligible to pay the health fee or receive services normally covered by the Fee. The Health Fee may be waived under certain conditions. A waiver can be granted if the student resides more than 50 miles away from campus and does not come to campus for research or other academic activity for the entire semester. Students studying at the Duke Marine Lab are not eligible for waiver. Duke employees and spouses of employees who are also students may request waiver. An optional summer health fee for students not enrolled in summer sessions is also available.
**Services Covered by the Health Fee.** The Health Fee covers most of the services at the Student Health Center if medically indicated and ordered by a student health provider. These include:

- medical care for acute and chronic illness and minor injuries
- one complete physical exam every two years
- annual gynecological exam
- some routine laboratory services including confidential pregnancy testing
- administration of allergy/immunotherapy shots
- TB skin tests
- nutrition consultation
- health promotion services

**Services Not Covered by the Health Fee.** If you are unsure whether a service is covered, please ask the Student Health reception staff in the clinic prior to receiving the service. You are financially responsible for the following:

- prescription drugs
- most laboratory services
- x-rays and other radiology studies
- vaccines
- medical care provided in the Emergency Department, hospital, or other non-student health facility
- care provided by specialist consultants, including those working within the Student Health facilities
- dental care
- routine eye exams
- pregnancy care or deliveries
- tests, procedures, and prescriptions not medically indicated, not on the approved list, or not ordered by Student Health providers
- immunizations/titers required for matriculation and travel

**Student Medical Insurance Plan (SMIP).** Health insurance is essential to protect against the high cost of unexpected illnesses or injuries that require hospitalization, surgery, or the services of specialists outside of Student Health. Therefore, all full-time and part-time degree seeking candidates who are in programs that require payment of the health fee are **required** to have insurance. For those who do not have insurance, Duke University sponsors a plan (SMIP) designed with students needs in mind. The SMIP provides protection 24 hours per day during the 12-month term of the policy of each student insured and is specifically designed to complement the coverage provided by the Fee. Students are covered on and off campus, at home, while traveling between home and school, and during interim vacation periods. Coverage for the student's spouse and dependent children also may be purchased. The charge for the SMIP will appear on the tuition bill and may be waived only by providing proof of adequate insurance coverage. Certain restrictions apply, for more information, see [http://www.studentaffairs.duke.edu/studenthealth](http://www.studentaffairs.duke.edu/studenthealth). Enrollment in the Duke SMIP is mandatory for J1/F1 visa holders.

**Counseling and Psychological Services (CAPS).** Counseling and Psychological Services (CAPS) provides a range of excellent counseling and psychiatric services to address the acute emotional and psychological difficulties of students. The professional staff is composed of psychologists, clinical social workers, and psychiatrists experienced in working with college students. They provide evaluation and brief counseling/psychotherapy for a wide range of concerns, including college adjustment, self-esteem and identity, family relationships, academic performance, and intimacy and sexuality. While students' visits with counselors are usually by appointment, emergencies are addressed when they arise.

Each semester, CAPS offers counseling groups and personal growth workshops focusing on enhanced self-understanding and coping strategies. These have been offered for second generation Americans; African-American students; students completing dissertations; students with eating disorders; and gay, lesbian, and bisexual students. Other groups and workshops have addressed such topics as eating and body image concerns, emotional regulation, meditation, and perfectionism.

The staff is available to the university community for consultation regarding student development and mental health. CAPS' staff work with campus personnel, including administrators, faculty, student health staff, religious life staff, resident advisors, and student groups, in meeting mental health needs identified through such liaisons. Staff members are also available to lead workshops and discussion groups on topics of interest to students.

CAPS, consistent with professional ethics and the North Carolina law, maintains a policy of strict confidentiality concerning information about each student's contact with CAPS. If a student desires information to be released, written authorization must be provided. CAPS' services are covered by the student health fee. There are no additional costs for these services. For more information, see the Web site at: [http://caps.studentaffairs.duke.edu](http://caps.studentaffairs.duke.edu), or call (919) 660-1000.
The Career Center. All Career Center services are available to advanced Duke students enrolled in the Graduate School and to alumni of its programs up to four years out. Career Center staff support graduate students in the assessment of their career objectives and in the search for appropriate employment—whether in the .edu, .com, or .gov sectors. Services for graduate students include confidential counseling, workshops for practical skill development, and special events to connect them with campus resources, alumni career advisors in DukeConnect, and employers interested in hiring master’s and PhD candidates for short-term or long-term opportunities. We encourage graduate students to begin to plan their transition to the workplace early and to develop skills for navigating its particular challenges. For information about our services, programs, and resources, see the graduate student section of the Career Center’s Web site: http://www.studentaffairs.duke.edu/career.

Student Affairs

The Office of Graduate Student Affairs. The central mission of Graduate Student Affairs (GSA) is to enhance the quality of graduate student life by working closely with individual students, student organizations, faculty, and other campus offices. The aim is to provide a broad array of programs on issues related to graduate student life such as health, safety, housing, mentoring, and professional development. GSA also has a particular role in establishing support services that address the specific needs of students from different ethnic backgrounds, international students, gay and lesbian students, students with disabilities, women, and other groups. This office is committed to helping students become active participants in the Duke University community. Graduate Student Affairs serves as a principal point of contact for all graduate students wishing to express their comments and concerns about the quality of graduate student life here at Duke. We urge you to take full advantage of the services offered by our office. You are welcome to come by at any time to talk about your experiences as a student or just to say hello. You can also consult us by telephone at 919-684-2056, by e-mail at grad-gsa@duke.edu, or visit our Web site: http://www.gradschool.duke.edu/gsa/.

Cocurricular Activities. Graduate students at Duke University are welcome to use such university recreational facilities as swimming pools, tennis courts, the golf course, and gyms. They may also affiliate with the choral, dance, drama, music, and religious groups. They may become junior members of the American Association of University Professors and may affiliate with Phi Beta Kappa and social fraternities.

A full program of cultural, recreational, and religious activities is presented by the Duke University Campus Ministry, the Duke University Union, the Office of Student Activities, and recreational clubs. The Duke University Union sponsors a wide range of programs through its committees, which are open to all segments of the campus community. Included are rock, jazz, and pop concerts; speakers; films; a film-making program; the largest fully student-run television station in the country; art exhibits in three galleries; and a broad program in crafts located in Southgate Dormitory and the Bryan University Center. The Aquatic Center, Central Campus pool, and East Campus Gymnasium pool are available to students, faculty, and staff families. The handball, racquetball, squash, and tennis facilities and the weight rooms on East and West Campus are also available. Interested students may participate in softball and other team sports.

The University Center complex includes the Bryan University Center, which houses the Information Center, two drama theaters, a film theater, lounges, stores, meeting rooms, games room, an art gallery, and other facilities; the West Union, which includes dining facilities; and Flowers Building, which includes student publications, Page Auditorium, and the university box office.

Inquiries should be directed to the Recreation Office, 105 Card Gymnasium; Duke Chapel; the Duke University Union, Bryan University Center; or the Office of Student Activities, Bryan University Center.

Full information regarding the scheduling of major events and programs for the entire year can be found on the Duke University online event calendar (http://calendar.duke.edu), and in the Duke Chronicle, published each Monday through Friday during the fall and spring and each Thursday during the first summer session.

The Center for Multicultural Affairs supports the campus in addressing the academic and socio-cultural needs of African, Asian, Latino, and Native American students, and conducts diversity education programs for the general student body. In addition, the Center offers the campus community a number of multimedia resources for programming and research purposes that cover a wide array of multicultural topics. Reservable space is available in the center for clubs and organizations to meet, as well as space where individual students can study and relax. The staff also provides technical support to individuals and organizations planning multicultural, racial, and ethnic specific events. The interests and cultural programming activities of student organizations are of major importance to the center. Dedicated to making diversity and community essential aspects of the Duke experience, the Center collaborates with other campus agencies to offer unique educational programs designed to explore the complex dynamics of creating an inclusive campus. For more information, visit the Web site: http://www.studentaffairs.duke.edu/mce.

The Community Service Center. The Community Service Center (CSC) is a clearinghouse for volunteer and community service activities available to students, faculty, and employees. Through the center, members of the Duke community can become involved with student service groups and Durham area agencies doing everything from tutoring and mentoring, caring for people with AIDS, and serving meals at local homeless shelters, to befriending senior citizens. The Community Service Center also sponsors speakers, special events, volunteer training sessions, and many other programs. In these ways, the CSC strives to raise awareness of contemporary social issues, support civic engagement,

**International House.** International House serves as the center for co-curricular programs for internationals and U.S. Americans interested in other cultures and people. As part of the Division of Student Affairs, the mission of International House is to provide educational services, advocacy, and outreach to the international population and the Duke/Durham community. In 2009-2010, there were over 2,000 international students from over 100 countries around the world enrolled at Duke.

Among the many programs offered, International House organizes an intensive orientation at the beginning of each semester. This year’s fall orientation will be held on August 18th. Prior to the fall orientation, International House, in collaboration with the Office of Graduate Student Affairs, Duke Visa Services, Community Housing, and Student Health, will offer an online orientation on June 7th.

International House also offers the following ongoing programs: the International Friends Program matching internationals with local families to provide cross-cultural learning; English Conversation Club and Spanish Conversation Hour for casual conversation in a small group setting; Duke Language Partners pairing internationals with domestic students for language exchange, and cross-cultural training for managing global diversity at the interpersonal and organization levels. International House also works with International Association, a student-run group that sponsors cultural and social events throughout the year.

For more information about International House, visit its Web site http://www.studentaffairs.duke.edu/ihouse e-mail: ihouse@duke.edu; phone: 919-684-3585.

**Jewish Life at Duke** is comprised of the Freeman Center for Jewish Life and the Rubenstein-Silvers Hillel. The Freeman Center provides a home for Jewish life on campus while the Rubenstein-Silvers Hillel provides exciting and innovative programming throughout the Duke community. The combination works to foster and enrich Jewish life through social, educational, religious, and cultural activities. A pluralistic approach to Judaism assures that all Jews, regardless of denomination, feel welcome in the building and at programs. Kosher dinners are served during the week at Henry’s Place in the Heyman Dining Hall at the Freeman Center and are available at other times by special arrangement. For more information, contact Jewish Life at Duke, Box 90936, Duke University, Durham, NC 27708; telephone, 919-684-6422; e-mail, jewishlife@duke.edu; Web site, http://www.studentaffairs.duke.edu/jewishlife.

**The Center for Lesbian, Gay, Bisexual, and Transgender Life.** The mission of the Center for Lesbian, Gay, Bisexual, and Transgender Life (Center for LGBT Life) is to provide education, advocacy, support, mentoring, and space for lesbian, gay, bisexual, transgender, transsexual, questioning, and straight-allied students, staff, and faculty at Duke, as well as alumni/ae and members of neighboring communities. Through its services, the Center for LGBT Life presents educational, cultural, and social opportunities for all students, faculty, staff, and alumni/ae to challenge intolerance and promote affirmation. Thus creating a more hospitable campus climate. Among its many purposes, the Center offers: (1) a safe space to discuss issues related to sexual orientation and gender identity and expression; (2) a friendly and comfortable location for LGBT persons and allies to socialize and discuss issues affecting the community; (3) a place for groups of students both undergraduate and graduate to meet and organize; (4) a resource center and library; (5) a place to work for advocacy on matters that relate to the Duke campus; and (6) a broad array of educational programming aimed at diverse audiences in and around the university. For more information, visit: http://lgbt.studentaffairs.duke.edu.

**The Mary Lou Williams Center for Black Culture.** The African American undergraduate student presence at Duke University began in 1963 when the University desegregated the campus with the admission of five African Americans. Over the next twenty years, the growing Black student population at Duke continued to advocate for the addition of faculty, staff, programs, and services to both represent and address the many and complex issues that emerged as a result of rising visibility on the University campus. Artist in Residence Mary Lou Williams was a strong mentor at Duke from 1977 until her death in 1981, and as a result, Duke University’s Center for Black Culture has borne her name since its dedication in September 1983.

The Mary Lou Williams Center for Black Culture is critically concerned with issues of race and the impact of social difference at the individual, interpersonal, and institutional levels. Through lectures, performances, exhibits, and informal gatherings, the Mary Lou Williams Center strives to foster an appreciation for and increase knowledge of the peoples, histories, and cultures of the African Diaspora and its many contributions to the world. Located on the second floor of the West Union Building, the Mary Lou Williams Center for Black Culture was relocated and newly renovated in 2003. It is a beautiful facility with oak paneled walls, grand windows, an exquisite baby grand piano, and an ever-expanding collection of photography and art on the walls that serves to visually represent Black culture at Duke University and beyond.

Among our services and resources is the lending library, which is a collection of more than 1,000 books, DVDs, audio resources, and other culturally relevant materials that may be borrowed by members of the Duke community. We also offer individual student counsel and advising to Black graduate, professional, and undergraduate organizations to assist with their leadership development and programming.

We welcome all who want to engage with and be empowered by a greater understanding of the Black experience, to view the Mary Lou Williams Center as their home away from home. To learn more, visit http://mlw.studentaf-
The Women’s Center. The Women’s Center promotes the full and active participation of women in higher education at Duke by facilitating discussions on feminism, gender equity, and diversity; providing opportunities for civic engagement and activism around gender and identity; and providing advocacy, support, and referrals for women on campus. The Center raises awareness of how gender norms affect both women and men on campus, and serves as an advocate for individuals and groups experiencing gender-related problems, such as sexual harassment, gender discrimination, or gender violence. Duke’s Office of Gender Violence Prevention and Intervention is also housed in the Women’s Center. The Women’s Center is located in 107 Few Fed, across the traffic circle from the Allen Building. For more information call (919) 684-3897 or visit the Web site at: http://www.studentaffairs.duke.edu/wc/.

Graduate and Professional Student Council. The Graduate and Professional Student Council (GPSC) is the representative body for students of Duke’s seven graduate and professional schools. The Council selects graduate students for membership on university committees, oversees election of the graduate and professional Young Trustee, andcoordinates social and community service events and activities throughout the year. Representatives of each department and officers of the Council are selected annually, but Council meetings and participation in most Council events are open to all students. The Council's electronic weekly publication, GPSCNews, is automatically distributed to all students. Visit the GPSC Web site at: http://gpsc.duke.edu/ to find more information on activities, connect with other graduate and professional students through the GPSC Forums, and learn more about other graduate student groups. E-mail GPSC (gpsc@duke.edu) to learn how you can be involved as a representative.

Religious Life. The Duke University Chapel, open from 8:00 a.m. until 10:00 p.m., provides a magnificent setting for daily prayer and meditation. In addition, a variety of worship experiences are provided throughout the week including the university service of worship at 11:00 A.M. each Sunday, noonday prayer each weekday during term, and choral vespers each Thursday at 5:15 P.M.

The one hundred and fifty-voice Chapel Choir is open by audition to all interested singers. Duke Campus Ministry invites graduate students to participate in the various religious life groups. Contact the Office of Dean of the Chapel or the assistant dean of the Chapel, Duke Chapel, for further details. For more information on Duke Chapel and the variety of Religious Life opportunities on campus, please visit, http://www.chapel.duke.edu, or call (919) 684-2909.

Goodson Chapel in Duke Divinity School also offers opportunities for daily prayer and meditation, open not only to divinity school students, but to the entire Duke University community. Services of morning prayer are held at 8 A.M. Monday through Friday. Worship services are held Tuesday, Wednesday, and Thursday of each week from 11:25 A.M. to 12:15 P.M. For more information on services at Goodson Chapel, call (919) 660-3539.
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