Bulletin of
Duke University

The Graduate School
2014-2015
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 2014-2015 and is accurate and current, to the greatest extent possible, as of June 2014. 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 does not tolerate harassment of any kind. Sexual harassment and sexual misconduct are forms of sex discrimination and prohibited by the university. Duke University has designated Dr. Benjamin Reese, vice-president for institutional equity, as the individual responsible for the coordination and administration of its nondiscrimination and harassment policies. The Office of Institutional Equity is located in Smith Warehouse, 114 S. Buchanan Blvd., Bay 8, Durham, NC 27708. Dr. Reese’s office telephone number is (919) 684-8222 and his e-mail address is ben.reese@duke.edu.

Questions or comments about harassment or discrimination can be directed to the Office for Institutional Equity, (919) 684-8222. Additional information, including the complete text of the harassment policy and appropriate complaint procedures, may be found by contacting the Office for Institutional Equity or visiting its website 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 federal Clery Act is available by visiting the Records Division, Duke University Police Department, 502 Oregon Street, Durham, NC 27708, or by calling (919) 684-4602. See http://duke.edu/police/news_stats/clery/index.php for more details.

The Family Educational Rights & Privacy Act (FERPA), 20 U.S.C § 1232g; 34 CFR Part 99, is a federal law that guides the release of students’ education records, of which disciplinary records are a part. For additional information about FERPA, see http://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html.

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, GA 30033-4097 or call (404) 679-4500 for questions about the accreditation of Duke University.
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## Academic Calendar 2014-15

### Summer 2014

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<tr>
<td>February 17</td>
<td>Monday. Registration begins for all summer sessions</td>
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<tr>
<td>May 14</td>
<td>Wednesday. Term I classes begin. The Monday class meeting schedule is in effect on this day. (Therefore, all summer classes meet this day.) Regular class meeting schedule begins on Thursday, May 15; Drop/Add continues</td>
</tr>
<tr>
<td>May 15</td>
<td>Thursday. Regular class meeting schedule begins</td>
</tr>
<tr>
<td>May 16</td>
<td>Friday. Drop/Add for Term I ends</td>
</tr>
<tr>
<td>May 26</td>
<td>Monday. Memorial Day holiday. No classes are held</td>
</tr>
<tr>
<td>June 11</td>
<td>Wednesday. Last day to withdraw with W from Term I classes</td>
</tr>
<tr>
<td>June 23</td>
<td>Monday. Term I classes end</td>
</tr>
<tr>
<td>June 24</td>
<td>Tuesday. Reading period</td>
</tr>
<tr>
<td>June 25</td>
<td>Wednesday. Term I final examinations begin</td>
</tr>
<tr>
<td>June 26</td>
<td>Thursday. Term I final examinations end</td>
</tr>
<tr>
<td>June 30</td>
<td>Monday. Term II classes begin</td>
</tr>
<tr>
<td>July 2</td>
<td>Wednesday. Drop/Add for Term II ends</td>
</tr>
<tr>
<td>July 4</td>
<td>Friday. Independence Day holiday. No classes are held</td>
</tr>
<tr>
<td>July 28</td>
<td>Monday. Last day to withdraw with W from Term II classes</td>
</tr>
<tr>
<td>August 7</td>
<td>Thursday. Term II classes end</td>
</tr>
<tr>
<td>August 8</td>
<td>Friday. Reading period (Until 7 p.m.)</td>
</tr>
<tr>
<td>August 8</td>
<td>Friday. Term II final examinations begin, 7 p.m.</td>
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<tr>
<td>August 10</td>
<td>Sunday. Term II final examinations end</td>
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### Fall 2014

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<tr>
<td>August 19</td>
<td>Tuesday. New graduate student orientation begins</td>
</tr>
<tr>
<td>August 19</td>
<td>Tuesday. New undergraduate student orientation begins</td>
</tr>
<tr>
<td>August 20</td>
<td>Wednesday. 11 a.m. Convocation for new undergraduate students; 4 p.m. Convocation for graduate and professional school students</td>
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<tr>
<td>August 25</td>
<td>Monday. 8:30 a.m. Fall semester classes begin; Drop/Add continues</td>
</tr>
<tr>
<td>September 1</td>
<td>Monday. Labor Day. Classes in session</td>
</tr>
<tr>
<td>September 5</td>
<td>Friday. Drop/Add ends</td>
</tr>
<tr>
<td>September 18/19</td>
<td>Thursday/Friday. 4:30 p.m. Founders' Day Convocation (exact day TBD)</td>
</tr>
<tr>
<td>September 21</td>
<td>Sunday. Founders' Day</td>
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<tr>
<td>October 10</td>
<td>Friday. Last day for reporting midterm grades</td>
</tr>
<tr>
<td>October 10</td>
<td>Friday. 7 p.m. Fall break begins</td>
</tr>
<tr>
<td>October 15</td>
<td>Wednesday. 8:30 a.m. Classes resume</td>
</tr>
<tr>
<td>November 5</td>
<td>Wednesday. Registration begins for Spring 2015</td>
</tr>
<tr>
<td>November 7</td>
<td>Friday. Last day to withdraw with W from Fall 2014 classes (Undergraduates Only)</td>
</tr>
<tr>
<td>November 19</td>
<td>Wednesday. Registration ends for Spring 2015</td>
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<tr>
<td>November 20</td>
<td>Thursday. Drop/Add begins for Spring 2015</td>
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<tr>
<td>November 25</td>
<td>Tuesday. 10:30 p.m. Thanksgiving recess begins</td>
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<tr>
<td>November 25</td>
<td>Tuesday. Graduate classes end</td>
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<tr>
<td>December 1</td>
<td>Monday. 8:30 a.m. Classes resume</td>
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<tr>
<td>December 1-8</td>
<td>Monday-Monday. Graduate reading period</td>
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<tr>
<td>December 5</td>
<td>Friday. Undergraduate classes end</td>
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<tr>
<td>December 6-8</td>
<td>Saturday-Monday. Undergraduate reading period</td>
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<td>December 9</td>
<td>Tuesday. Final examinations begin (9 a.m.)</td>
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<td>December 14</td>
<td>Sunday. 10 p.m. Final examinations end</td>
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### Spring 2015

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<td>January 4-6</td>
<td>Sunday-Tuesday. Undergraduate Winter Forum</td>
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<td>January 7</td>
<td>Wednesday. 8:30 a.m. Spring semester begins: The Monday class meeting schedule is in effect on this day; Regular class meeting schedule begins on Thursday, January 8; Classes meeting in a Wednesday/Friday meeting pattern begin January 9; Drop/Add continues</td>
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<tr>
<td>January 8</td>
<td>Thursday. Regular class meeting schedule begins</td>
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<tr>
<td>January 19</td>
<td>Monday. Martin Luther King, Jr. Day holiday: classes are rescheduled on Wednesday, January 7</td>
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<td>January 21</td>
<td>Wednesday. Drop/Add ends</td>
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<td>February 16</td>
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<tr>
<td>February 20</td>
<td>Friday. Last day for reporting midterm grades</td>
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<td>March 6</td>
<td>Friday. 7 p.m. Spring recess begins</td>
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<tr>
<td>March 16</td>
<td>Monday. 8 a.m. Classes resume</td>
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<td>March 25</td>
<td>Wednesday. Last day to withdraw with W from Spring 2015 classes (Undergraduates Only)</td>
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<td>April 1</td>
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<td>April 10</td>
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<tr>
<td>April 11</td>
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<td>Thursday-Sunday. Graduate reading period</td>
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<td>April 22</td>
<td>Wednesday. Undergraduate classes end</td>
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<td>April 23-6</td>
<td>Thursday-Sunday. Undergraduate reading period</td>
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<td>April 27</td>
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<td>May 2</td>
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<td>May 8</td>
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University Administration

General University Administration
Richard H. Brodhead, PhD, President
Sally Kornbluth, PhD, Provost
Tallman Trask III, MBA, PhD, Executive Vice President
Pamela J. Bernard, JD, Vice President and General Counsel
Kyle Cavanaugh, MBA, Vice President for Administration
Tracy Futhey, MS, Vice President, Information Technology and Chief Information Officer
Michael Merson, MD, Interim Vice President and Vice Provost, Global Strategy and Programs
Larry Moneta, EdD, Vice President, Student Affairs
John J. Noonan, MBA, Vice President, Facilities
Benjamin Reese, PsyD, Vice President, Office for Institutional Equity
Richard Riddell, PhD, Vice President and University Secretary
Michael J. Schoenfeld, MS, Vice President, Public Affairs and Government Relations
Robert Shepard, PhD, Vice President, Alumni Affairs and Development
Timothy Walsh, MBA, Vice President for Finance
Kevin M. White, PhD, Vice President and Director of Athletics
Phail Wynn, Jr., MBA, EdD, Vice President, Durham and Regional Affairs
Nancy C. Andrews, MD, PhD, Dean, School of Medicine
William Boulding, PhD, Dean, Fuqua School of Business
Marion E. Broome, PhD, RN, FAAN, Dean, School of Nursing
Kelly Brownell, PhD, Dean, Sanford School of Public Policy
Richard Hays, PhD, Dean, Divinity School
Thomas C. Katsouleas, PhD, Dean, Pratt School of Engineering
David F. Levi, JD, Dean, School of Law
Paula B. McClain, PhD, Dean, Graduate School
Stephen Nowicki, PhD, Dean and Vice Provost, Undergraduate Education
Laurie L. Patton, PhD, Dean of Arts and Sciences
Luke A. Powery, ThD, Dean of Duke Chapel
Alan Townsend, PhD, Dean, Nicholas School of the Environment
Nancy Allen, MD, Vice Provost, Faculty Diversity and Faculty Development
Lawrence Carin, PhD, Vice Provost for Research
Deborah Jakubs, PhD, Vice Provost for Library Affairs
Scott Lindroth, PhD, Vice Provost for the Arts
James S. Roberts, PhD, Executive Vice Provost for Finance and Administration
Susan Roth, PhD, Vice Provost for Interdisciplinary Studies
Keith Whitfield, PhD, Vice Provost for Academic Affairs
Neal F. Triplett, MBA, President & CEO, DUMAC

General Academic Administration
Sally Kornbluth, PhD, Provost
Stephen Nowicki, PhD, Dean and Vice Provost for Undergraduate Education
Nancy B. Allen, MD, Vice Provost for Faculty Diversity and Faculty Development
Katharine Bader, MA, Assistant Vice Provost and Director, Student Information Services and Systems
Bruce W. Cunningham, PhD, Assistant Vice Provost and University Registrar
Kimberley 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 for Undergraduate Education and Director of Administrative and Community Support Services
Scott Lindroth, PhD, Vice Provost for the Arts
Jacqueline Looney, EdD, Associate Vice Provost for Academic Diversity and Associate Dean of the Graduate School
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
Keith W. Whitfield, PhD, Vice Provost for Academic Affairs

Graduate School Administration
Paula D. McClain, PhD, Dean
John A. Klingensmith, PhD, Associate Dean
Jacqueline Looney, EdD, Senior Associate Dean
Cynthia Robertson, MBA, Associate Dean
General Information

History of Duke University

Duke University traces its roots to 1838 in nearby Randolph County, where local Methodist and Quaker communities joined forces to support a permanent school that they named Union Institute. After a brief period as Normal College (1851-59), the school changed its name to Trinity College in 1859 and became a liberal arts college affiliated with the Methodist Church. The college moved to the growing city of Durham in 1892 when Washington Duke provided financial assistance and another local businessman, Julian S. Carr, donated land. In December 1924, the trustees graciously accepted the provisions of James B. Duke's indenture creating the family philanthropic foundation, the Duke Endowment, which provided for the expansion of Trinity College into Duke University.

As a result of the Duke gift, Trinity underwent both academic and physical expansion. The original Durham campus became known as East Campus when it was rebuilt in stately Georgian architecture. West Campus, Gothic in style and dominated by the soaring tower of the Duke Chapel, opened in 1930.

In 1972, the men’s and women’s colleges merged into the Trinity College of Arts & Sciences. Academic expansion of the university throughout its history has also included the establishment of graduate and professional schools. Duke now is composed of ten schools, including The Graduate School, Duke Divinity School, the School of Medicine, the School of Nursing, the School of Law, the Pratt School of Engineering, The Fuqua School of Business, the Nicholas School of the Environment, and the Sanford School of Public Policy, along with international outposts, including one in Kunshan, China.

Today, Duke embraces a diverse community of learners, including approximately 6,500 undergraduates and 7,500 graduate and professional students from a multiplicity of backgrounds. For more historical information, visit http://library.duke.edu/rubenstein/uarchives.

History of The Graduate School

The Duke University Graduate School, established in 1926, currently enrolls approximately 3,200 graduate students in a wide range of research master’s (MA/MS) and doctoral (PhD) degree programs. We offer graduate education in more than seventy departments or programs of study where students work closely with faculty across Duke’s ten other schools. By attracting the best domestic and international graduate students to work in cutting-edge fields of knowledge, The Graduate School plays a key role in supporting the Mission of Duke University by serving:

“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 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.”

The Graduate School helps to strengthen the intellectual life of the university by supporting and expanding on the scholarly activities of our faculty. Moreover, our graduate students have many opportunities to participate in leadership roles on campus or in surrounding communities, to serve as teachers and mentors who bridge faculty and undergraduate students, or to develop professionally through conducting and presenting their own research.

The Graduate School welcomes prospective students and guests to visit us in our spacious home, located on a quiet corner of Campus Drive on Duke’s West Campus. Built in 1931 for the family of Duke administrator, Robert L. Flowers, our historic stone building later housed University Development offices prior to The Graduate School’s move in 2009. Our central location provides services for more than seventy graduate departments and programs, working in conjunction with the other nine professional schools; we are home to Graduate Academic Affairs, Admissions, Finance and Administration, Student Affairs, and Data Services.
Graduate School Faculty
(as of July 1, 2014)

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Alexander Rosenberg, PhD, Professor in Philosophy
M. Zachary Rosenthal, PhD, Assistant Professor in Psychiatry and Behavior Sciences and Psychology and Neuroscience
Allen D. Roses, MD, Professor in Neurology
Ashleigh S. Rosette, PhD, Associate Professor in Business Administration and Sociology
Susan Roth, PhD, Professor in Psychology and Neuroscience and Psychiatry and Behavioral Science
Virginia Louise Roth, PhD, Associate Professor in Biology Evolutionary Anthropology
C. Kavin Rowe, PhD, Associate Professor in Divinity
David C. Rubin, PhD, Professor in Psychology and Neuroscience
Juan F. Rubio-Ramirez, PhD, Professor in Economics
M. Kathy Rudy, PhD, Professor in Women's Studies
Philip Rupprecht, PhD, Associate Professor in Music
Laura Rusche, PhD, Assistant Professor in Biochemistry and Molecular Genetics and Microbiology

S

Daniel Raphael Saban, PhD, Assistant Professor in Ophthalmology and Immunology
Philipp Sadowski, PhD, Assistant Professor in Economics
Anne-Gaëlle Salier, DPhil, Assistant Professor in Romance Studies
James E. Salzman, JD, Professor in Law and Environmental Science and Policy
Ehsan Samei, PhD, Professor in Radiology, Electrical and Computer Engineering, and Physics
John Howard Sampson, MD/PhD, Professor in Surgery, Biomedical Engineering, Immunology, Radiation Oncology, and Pathology
Seth G. Sanders, PhD, Professor in Economics and Public Policy
Leslie D. Saper, PhD, Professor in Mathematics
Guillermo Sapiro, D.Sc., Professor in Electrical and Computer Engineering, Biomedical Engineering, and Computer Science
Marcella Sarzotti-Kelsoe, PhD, Research Professor in Immunology and Surgery
Katherine Schipper, PhD, Professor in Business Administration
Nestor Schmajuk, PhD, Professor in Psychology and Neuroscience and Electrical and Computer Engineering
Lukas Schmid, PhD, Associate Professor in Business Administration
Amy K. Schmid, PhD, Assistant Professor in Biology
Scott Schmidler, PhD, Associate Professor in Statistical Science and Computer Science
Daniel O. Schmitt, PhD, Professor in Evolutionary Anthropology
Susan Moeller Schneider, RN/PhD, Associate Professor in Nursing
Chadmark L. Schoen, PhD, Professor in Mathematics
Kate Scholberg, PhD, Professor in Physics
David W. Schomberg, PhD, Associate Professor in Obstetrics and Gynecology and Cell Biology
Christopher Schroeder, JD, Professor in Law and Public Policy
Maria A. Schumacher, PhD, Associate Professor in Biochemistry
Guglielmo Scovazzi, PhD, Associate Professor in Civil and Environmental Engineering and Mechanical Engineering and Materials Science
William Seaman, PhD, Professor in Art, Art History, and Visual Studies
Patrick C. Seed, MD/PhD, Associate Professor in Pediatrics, Molecular Genetics and Microbiology, and Surgery
Victoria L. Seewaldt, MD, Professor in Medicine
W. Paul Segars, PhD, Associate Professor in Radiology
Gregory D. Sempowski, PhD, Assistant Research Professor in Medicine and Pathology
Lori A. Setton, PhD, Associate Professor in Biomedical Engineering
James Y. Shah, PhD, Associate Professor in Psychology and Neuroscience
Suzanne E. Shanahan, PhD, Associate Research Professor in Sociology
Kevin Shang, PhD, Associate Professor in Business Administration
Merrill Shatzman, MFA, Professor of the Practice in Art, Art History, and Visual Studies
Edward J. Shaughnessy, PhD, Professor in Mechanical Engineering and Materials Science
A. Jonathan Shaw, PhD, Professor in Biology
Ryan Jeffrey Shaw, PhD, Assistant Professor in Nursing
Blair Sheppard, PhD, Professor in Business Administration and Psychology and Neuroscience
Andrew Sherwood, PhD, Professor in Psychiatry and Behavior Sciences and Psychology and Neuroscience
Nina Tang Sherwood, PhD, Assistant Research Professor in Biology and Molecular Genetics and Microbiology
David R. Sherwood, PhD, Associate Professor in Biology
Mari Shinohara, PhD, Assistant Professor in Immunology and Molecular Genetics and Microbiology
Gangadhar P. Shukla, PhD, Professor of the Practice in Public Policy
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James N. Siedow, PhD, Professor in Biology
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David Aaron Siegel, PhD, Associate Professor in Political Science
Ilene C. Siegler, PhD/MPH., Professor in Psychiatry and Behavior Sciences and Psychology and Neuroscience
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Debra Lynn Silver, PhD, Assistant Professor in Molecular Genetics and Microbiology, Cell Biology, and Neurobiology
Irene M. Silverblatt, PhD, Professor in Cultural Anthropology and Women's Studies
Leigh Ann Simmons, PhD, Associate Professor in Nursing
Sidney Arthur Simon, PhD, Research Professor in Neurobiology
Walter Sinnott-Armstrong, PhD, Professor in Philosophy
Sim B. Sitkin, PhD, Professor in Business Administration
David M. Skatrud, PhD, Adjunct Professor in Physics
Jesse H. Pate Skene, PhD, Associate Professor in Neurobiology
Frank A. Sloan, PhD, Professor in Economics, Nursing, and Public Policy
Theodore Alan Slotkin, PhD, Professor in Pharmacology and Cancer Biology, Psychiatry and Behavioral Sciences, and Neurobiology
David R. Smith, PhD, Professor in Electrical and Computer Engineering and Physics
J. Warren Smith, PhD, Associate Professor in Divinity
James E. Smith, PhD, Professor in Business Administration
Kathleen K. Smith, PhD, Professor in Biology
Martin D. Smith, PhD, Professor in Environmental Science and Policy and Marine Science and Conservation
Stephen William Smith, PhD, Professor in Biomedical Engineering and Radiology
Lynn Smith-Lovin, PhD, Professor in Sociology and Psychology and Neuroscience
Joshua E. S. Socolar, PhD, Professor in Physics
Scott H. Soderling, PhD, Associate Professor in Cell Biology and Neurobiology
Jack B. Soll, PhD, Associate Professor in Business Administration
Harris Scott Solomon, PhD, Assistant Professor in Cultural Anthropology
Helen Solterer, PhD, Professor in Romance Studies
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Jing-Sheng (Jeannette) Song, PhD, Professor in Business Administration
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Joshua Sosin, PhD, Associate Professor in Classical Studies and History
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Leonard Spicer, PhD, Professor in Radiology and Biochemistry
Thomas Arthur Spragens, PhD, Professor in Political Science
Roxanne P. Springer, PhD, Professor in Physics
Gopal Sreenivasan, PhD, Professor in Philosophy and Medicine
Herman Staats, PhD, Professor in Pathology, Medicine, and Immunology
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Bruce Alan Sullenger, PhD, Professor in Surgery Molecular Genetics and Microbiology, and Pharmacology and Cancer Biology
Beth A. Sullivan, PhD, Assistant Professor in Molecular Genetics and Microbiology
Peng Sun, PhD, Assistant Professor in Business Administration
Tai-ping Sun, PhD, Professor in Biology
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Susan Willis, PhD, Associate Professor in Literature and English
William G. Wilson, PhD, Associate Professor in Biology
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Marty Woldorff, PhD, Professor in Psychiatry and Behavior Sciences and Neurobiology
Patrick Wolf, PhD, Associate Professor in Biomedical Engineering
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David Wong, PhD, Professor in Philosophy
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Ying Wu, PhD, Professor in Physics
Qiuwen Wu, PhD, Professor in Radiation Oncology

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Jun Yang, PhD, Professor in Computer Science
Ming Yang, PhD, Assistant Professor in Business Administration
Chung-Hui (Rebecca) Yang, PhD, Assistant Professor in Neurobiology
Weitao Yang, PhD, Professor in Chemistry and Physics
Xiaowei Yang, PhD, Associate Professor in Computer Science
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Fan Yuan, PhD, Associate Professor in Biomedical Engineering and Ophthalmology
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Pei Zhou, PhD, Associate Professor in Biochemistry and Chemistry
Xin Zhou, PhD, Professor in Mathematics
Yuan Zhuang, PhD, Professor in Immunology and Molecular Genetics and Microbiology
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Message from the Dean

Welcome to The Graduate School. Duke is an energetic and vibrant university at the forefront of graduate education. The Graduate School is central to the academic mission of the university, and graduate faculty research is on the cutting-edge of knowledge in the various disciplines and programs represented in the school. The hallmark of graduate education at Duke is a rich blend of deep, specialized knowledge in a field of study, intersecting with the boundaries and frontiers of other fields. Multidisciplinary approaches are seen as key to discovery and the production of knowledge. Collaborative faculty and graduate student research and study groups coalesce around problems and themes in many different university settings for work beyond departmental and individual program contexts.

The Graduate School is committed to the success of its students and serves as an advocate for their intellectual development. We believe that the analytic and research skills formed and honed during graduate study are critical for success in a variety of professional contexts. We are committed to helping students think about and begin to shape their professional career trajectories from the moment they begin their graduate student careers at Duke. We know, however, that student success encompasses aspects of their lives beyond their academic work, and believe that graduate study should be viewed as part of a well-rounded life experience. The school offers many programs to help support and enrich the lives of graduate students during their years at Duke.

Duke’s location in the Research Triangle (Raleigh-Durham-Chapel Hill) facilitates contact with other major universities and with public and private institutes and firms. Outreach to these communities is an integral part of the Duke graduate experience, both academically and culturally. To come to Duke University for graduate study is to encounter the welcoming environment of an educational community dedicated to the pursuit of excellence and to the production of knowledge that will serve the broader society.

Paula D. McClain, PhD, Dean
The Graduate School
Duke University
Degree and Nondegree Admission

Any person who wishes to undertake graduate work at Duke University, whether for degree or nondegree 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 US bachelor's degree) from an accredited institution and, for almost all degree programs, satisfactory scores on the Graduate Record Examination (GRE). International applicants (both degree and nondegree) 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 “Departments, Programs, and Course Offerings” on page 66.”
An applicant who does not intend to earn an advanced degree at Duke but who wishes to take graduate courses may apply for nondegree admission. Such admission is granted in two different categories: (1) admission as a nondegree student affiliating with a particular department; or (2) admission through the Office of Continuing Studies as a nondegree student without departmental affiliation. Credits earned by nondegree 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.

A student who has discontinued a program of graduate degree work and who wishes to reenroll must send a written request for readmission to The Graduate School’s Office of Academic Affairs. The dean of The Graduate School will make the final decision regarding all requests for readmission.

A student who enters The Graduate School in a master’s program must submit a new application to be considered for a doctoral program.

Application Procedures

A person seeking admission to The Graduate School may access application and program information online 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 included as part of the submission of the online application. The application fee is $80. The required supporting documents are: (1) one copy of a transcript from each undergraduate or graduate institution attended; (2) three letters of recommendation; (3) official Graduate Record Examination (GRE) General Test scores for applicants to most programs; and (4) official scores on the GRE Subject Tests for applicants to certain specified departments.

If an applicant accepts an offer of admission, he or she must send an official, confidential transcript to The Graduate School for each institution listed in the application. The Graduate School reserves the right to revoke any offer of admission in the case of a discrepancy between the transcript included in the application and the official transcript.

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

Those applying for admission and award should take the GRE in time for official scores to reach The Graduate School by the appropriate application deadline. Information on the dates and locations of the Graduate Record Examinations can be obtained from the applicant's educational institution or the Educational Testing Service GRE website at http://www.gre.org.

TOEFL/IELTS Policy for International Applicants. If an applicant’s first language is not English, the applicant must 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).

English Language Requirements for International Students. In addition to submitting an IELTS or TOEFL score, international students whose first language is not English must demonstrate proficiency in academic English by taking oral and written exams upon their arrival at Duke. Depending on their exam results, students are either exempted from or placed into one or more English for international students (EIS) courses. Students with EIS requirements must begin these courses in their first year of study.

Part-Time Graduate Study. Very few graduate departments will consider applications from applicants wishing to pursue degree study on a part-time basis. Contact your department of interest to determine whether they accept part-time students. 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.

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

2. All fees are based on current charges and are subject to change without notice.

3. Exceptions are the master of arts in liberal studies (MALS), master of fine arts in experimental and documentary arts (MFAEDA), master of science in global health (MScGH), and doctor of philosophy (PhD) in business administration programs.
Continuing Studies Procedures. An applicant seeking admission as a nondegree continuing studies graduate student at Duke must have received a bachelor’s degree from a fully accredited college or university. More information regarding continuing studies at Duke is available on the Duke University Continuing Studies website at 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, gender identity, sex, or age.

Application files are assembled in The Graduate School admissions office, where all official record-keeping is maintained. 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. All offers of formal admission to The Graduate School are made by the dean. The process of admission is not complete until the student accepts the offer online via the Applicant Self-Service system.

An admission offer is only for the semester, program, and degree specified in the letter of admission. Requests for deferral are rarely approved by The Graduate School. Valid reasons for a deferral are health issues, visa issues which are beyond the student’s control, or military service.

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. 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 application deadlines. Only complete applications can be considered. To ensure that the admissions office will have adequate time to assemble all items submitted on an applicant’s behalf, application materials should be submitted at least two weeks before the stated deadlines.

Consult The Graduate School website (http://gradschool.duke.edu/admissions/deadlines/index.php) for a more detailed explanation of deadlines and their enforcement.

Fall Semester

December 8. Priority deadline for submission of PhD applications for fall semester admission and award
January 31. Priority deadline for submission of master’s applications for fall semester admission and award

Applications submitted by these dates are guaranteed a review by the departmental admissions committees. 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 applicants seeking fall admission should meet the December 8 deadline, since it is likely that enrollment in many departments will be filled soon after December 8.

Spring Semester

October 15. Deadline for submission of applications for the spring semester, space permitting. Very few departments accept new students for the spring semester, and financial aid is not readily available for spring matriculants.

Summer Session

Those seeking admission to The Graduate School for the summer session should apply in accordance with the fall deadline schedule. There are two summer sessions, typically running from mid-May to late June and from early July to mid-August. Very few departments accept new students for the summer session. With the exception of applicants to the master of arts in teaching and the PhD in economics programs, applicants who wish to apply for summer admission must obtain special permission from the department of interest and The Graduate School.
Tuition and Fees

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. The figures are estimates for 2014-2015 and are subject to change.

PhD Tuition

PhD tuition is charged on a per semester basis. For 2014-2015, the tuition charge for PhD students in their first three years of study is $22,880 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 graduate level work done at Duke prior to matriculation. Students in their fourth year of study and beyond are charged a reduced tuition rate of $3,162 per academic term. All PhD students, regardless of year of study, will be charged the reduced tuition rate of $3,162 for the Summer 2015 term.
Master’s Tuition

Master’s tuition for full-time study is charged on a per semester basis. For 2014-2015, the tuition charge for full-time master’s students is $22,880 per academic semester. Master’s students are required to enroll in and pay tuition for three full-time semesters of study, or the part-time equivalent thereof. Upon meeting the three-semester requirement, master’s students may convert to part-time academic status and will be charged a per credit rate of $2,765 for all remaining credits. Master’s students are also charged a part-time rate for summer coursework, not to exceed half the full-time rate for each summer term. Incoming students who are approved to attend on a part-time basis are also charged the per credit rate of $2,765.

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 $684 ($342 per semester). For Summer 2015 the fee is estimated at $242. This fee is distinct from health insurance and does not provide major medical coverage.

Recreation Fee

All graduate students will be charged a recreation fee for the use of on-campus facilities. The fee is $120 per semester. The fee is mandatory for PhD students in their first three years of study and master’s students in any year of students. Use of the recreational facilities and payment of the fee is optional for PhD students in their fourth or later years.

Student Activity and Student Services Fees

All graduate students will be charged student activity fees of $16.75 and student services fees of $10.00 per academic semester.

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 website at http://registrar.duke.edu/.

Other Miscellaneous Fees

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 fee is charged for other students.

Parking Fee

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

Living Expenses

Health Insurance

Students will be charged for health insurance in the fall semester, unless proof of other comparable health insurance is provided. For 2014-2015, health insurance is estimated to be $2,100 for the full plan year beginning August 1, 2014, and ending July 31, 2015.

Books and Supplies

Books and supplies for 2014-2015 are estimated at $1,240 for the year.
General Living Expenses

Room and board, transportation, personal, and miscellaneous costs are estimated at $1,931 per month. For detailed information on the complete cost of attendance for PhD and master’s students, please visit The Graduate School Financial Support website at http://gradschool.duke.edu/financial_support/.

Payment Policies

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. Nonregistered 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

Refund Policies

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 percent refund*
• Withdrawal during the third, fourth, or fifth week of classes: 60 percent refund*
• Withdrawal during the sixth week of classes: 20 percent 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.

PhD Funding

The contributions of graduate students are highly valued in the university and Duke has a strong commitment to fully fund the PhD students it selects for graduate study. The Graduate School and its graduate programs offer a wide array of financial support. Funding is available from annually allocated fellowship awards funds, instruction, endowed fellowships, foundation and other private support, as well as federal and privately sponsored research grants, training grants, and fellowships. PhD students are also encouraged to independently seek out external funding as these opportunities often provide valuable recognition of a student’s academic potential and promise.

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 the majority of humanities
and social science departments are currently supported for nine months, with summer research fellowship support guaranteed for students in their first two years, and summer fellowship support available for advanced students on a competitive basis. In natural science departments nine-month awards are also typical although summer support for PhD students from research assistantships, undergraduate summer session teaching positions, summer fellowships and/or departmental funds is frequently available. In the basic medical sciences and engineering departments support is typically provided for twelve months.

Department and Program Fellowships and Assistantships

Tuition and fee scholarships for study toward a PhD are provided by The Graduate School. For information about stipends and/or assistantship salaries 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, mandatory fees, and health insurance.
- **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.

Some 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 website at [http://www.fafsa.ed.gov/](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, Latin American and Caribbean studies, nanoscience, visual studies, and in centers such as the Kenan Institute 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 PhD students. For incoming students, selection is based on departmental nomination during the application process. 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 Graduate School fellowship awards for continuing students should follow the application procedures listed on The Graduate School website. Selection of university award recipients is made on the basis of academic merit and departmental recommendations.

Students holding a competitive graduate school fellowship are not permitted to hold other internal or external fellowships or Duke employment concurrent with The Graduate School award without prior approval from the dean of The Graduate School. Typically, fellowships for both incoming and continuing students will provide a full tuition and fee scholarship, health insurance, and a nine- or twelve-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

**Chancellor's Scholarship.** The Chancellor's Scholarship is awarded to incoming graduate students studying biomedical sciences in the School of Medicine. 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.
Dean’s Graduate Fellowship. The Dean’s Graduate Fellowship is a four-year fellowship provided 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. The Graduate School’s commitment to promoting and benefiting from diversity leads it to encourage nominations of students who are African American, American Indian/Alaskan Native, and Hispanic/Latino Americans. All nominees must be US citizens.

James B. Duke Fellowship. The James B. Duke 100th Anniversary Fund provides fellowships for students who wish to pursue a program leading to the PhD in The Graduate School at Duke University. Its objective is to aid in attracting and developing outstanding scholars at 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 national fellowships.

Latin American and Caribbean Studies Fellowship. These competitive fellowships provide $5,000 stipend supplements to applicants in any PhD program at Duke who are interested in Latin American and Caribbean studies.

Nathan J. Perilman Fellowship in Judaic Studies. Offered to incoming graduate students, this most prestigious fellowship in Jewish Studies honors the memory of Rabbi Nathan Perilman, formerly of New York City’s Temple Emmanu-El, who after retirement, joined the Jewish community in the Triangle area.

Pratt-Gardner Graduate Fellowship. The W.H. Gardner, Jr. Society of Engineering endowment fund provides fellowships for students in the Pratt School of Engineering who wish to pursue a program leading to the PhD in The Graduate School at Duke University. Its objective is to aid in attracting and developing outstanding scholars at Duke. Selection of recipients is made by a faculty committee upon nomination by the appropriate engineering department.

University Scholars Fellowship. The University Scholars Program was created in 1998 with a gift from 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.

Fellowships for Continuing Students

Bass Fellowships for Undergraduate Instruction are funded through the Anne T. and Robert M. Bass Endowment Fund for the Bass Undergraduate Instructional Program. This endowment supports The Graduate School’s mission to train the educators and professionals of the future. Students must be enrolled in The Graduate School Certificate of College Teaching program to be eligible for this fellowship award.

Phillip Jackson Baugh Fellowship for Graduate Students in Anthropology, Economics, Psychology, and Sociology. This one-year fellowship aims to promote careers and interest in the areas of aging and human development. The Baugh Fellowship provides a nine-month stipend, full tuition and fee scholarships, and Duke student medical insurance for one advanced graduate student each year.

Boone Fellowships for Canadian Graduate Students, funded through the Myra and William Waldo Boone Endowment provides a nine-month stipend, full tuition and fee scholarships, and Duke student medical insurance for up to three graduate students each year.

Conference Travel Awards fund advanced students who are presenting papers at national and international conferences. The Graduate School will contribute 70 percent of actual travel costs, up to $525 for domestic travel, and $700 for international travel, for students who have completed their preliminary examinations and are presenting a paper or poster at a national or international conference. The student’s department is expected to provide the remaining 30 percent.

Evan Frankel Fellowships for Students in the Humanities are awarded to advanced doctoral students in the write-up stage of their dissertation. These fellowships provide a nine-month stipend, full tuition and fee scholarships, and Duke student medical insurance for two graduate students each year.

Ottis Green Fellowship. Established to further the development of talented, industrious teachers and educators, this one-year fellowship is open to all PhD students studying in the humanities or social sciences. Preference will be given to students working in history, economics, social sciences, or religion, who have demonstrated their
commitment to preparing themselves for careers of teaching and education by participating in the Preparing Future Faculty (PFF) or Certificate in College Teaching (CCT) programs.

**E. Bayard Halsted Scholarships** for Duke graduates studying science, history, or journalism are awarded to graduate students who earned their undergraduate degree from any department at Duke University and who are pursuing advanced studies at Duke University in the areas of science, history, or journalism. This scholarship provides a nine-month stipend, full tuition, health and recreation fee scholarships, and Duke student medical insurance for up to three graduate students each year.

**Price Graduate Fellowships in Humanities/History.** These fellowships are funded through the Julian Price Fellowship Endowment. Students of humanities and history disciplines are eligible to complete for this fellowship which provides a nine-month stipend, full tuition and fee scholarships, and Duke student medical insurance for up to five graduate students each year. Each recipient will also receive a $5,000 award to be used exclusively to cover expenditures for research. These expenditures can include travel for research purposes, attendance at conferences, and/or purchase of supplies or equipment necessary to the research project.

**Sigma Xi Matching Grants.** 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.

**David M. Rubenstein Rare Book & Manuscript Library Internships.** Four Special Collections Library internships (reference, archival processing, advertising history, and African American studies) are jointly funded by the James B. Duke 100th Anniversary Fund and the Perkins Library. These nine-month internships provide a stipend, tuition and fee scholarships, and Duke student medical insurance for advanced graduate students conducting research in these areas.

**The Anne Firor Scott Dissertation Completion Fellowship** was created in honor of Dr. Scott, a pioneer historian of American women. Fellows will be expected to engage in significant work in public scholarship, for and with the broader community outside of Duke.

**Sterns Fellowships** funded through the Katherine Goodman Stern Fellowship Endowment, provide funding to students in their final year of dissertation research. These fellowships provide a nine-month stipend, full tuition and fee scholarships, and Duke student medical insurance for up to eight graduate students each year.

**Summer Research Fellowships.** Summer research fellowships are available to students in the humanities and social sciences. In addition to summer tuition and fees, the fellowship awards a summer stipend of $5,500. Summer Research Fellowships are supported by The Graduate School Annual Fund and the following endowments:

- Bertha and Richard G. Alexander Fund
- Alix Family Graduate Fellowship Endowment Fund
- Arcapita Graduate Fellowship Fund
- Anne T. and Robert M. Bass Fellowship Fund
- Black Family Fellowship Fund
- Clinical Faculty Arts and Sciences Scholarship/Fellowship Fund
- Davidson Family Endowment Fund
- James B. Duke 100th Anniversary Fund
- Feibusch Family Fellowship Endowment Fund
- Foster-Coomes Scholarship Fund
- John Hope Franklin Fellowship Fund
- Graduate School Arts and Sciences Fellowship Fund
- Graduate School Fellowship Endowment Fund
- John T. Grigsby Fellows Endowment Fund
- Stuart Irwin Harris Fellowship Endowment Fund
- Alice Blackmore Hicks Fellows Endowment Fund
- M. Anne Hill Fellowship Endowment Fund
- William and Janet Hunt Graduate Fellowship
- Jess and Minnie Brady Jaffrey College Scholarship Fund
- Jenkins Family Graduate Fellowship Endowment Fund
- Kline Family Fellowship Fund
• Cookie and Henry Kohn Fellowship Endowment Fund
• William McCormick Graduate Fellowship Endowment Fund
• Wayne and Virginia McLaurin Summer Research Fellowship
• John Hawkins Noblitt Graduate Fellowship Endowment Fund
• Dr. James W. Plonk Graduate Fellowship Endowment
• Fred and Barbara H. Sutherland Fellowship Endowment
• Allen and Joyce Temple Graduate Fellowship Endowment Fund
• Gene L. and Alice Stroude Winegardner Endowment
• James and Roberta Wilson Woodress Memorial Endowment Fund
• Judy C. Woodruff Fellowship Endowment Fund

Aleane Webb Dissertation Research Awards. This award provides small grants for dissertation research projects. This fund was created to assist graduate students in funding miscellaneous projects associated with research. Eligible projects include the purchase of microfilm, photographic development of slides, and graphic reproduction. Travel and typing costs will not be considered for this award. The Graduate School will award up to $500 per project to approximately seven students per year.

Jo Rae Wright Fellowship for Outstanding Women in Science. Created in memory of our dear friend and colleague, Jo Rae Wright, who served as dean of The Graduate School from 2006 until 2011. The fellowship is funded through an endowment given in her name to recognize one PhD student in the biomedical sciences and one in the natural sciences whose research shows particular creativity and promise. The two recipients will each be awarded a $5,000 supplement to any existing funding that they may possess.

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.

James B. Duke International Research Travel Fellowships for advanced students are funded through the James B. Duke 100th Anniversary Fund and are awarded to up to ten students each year who require international travel to conduct dissertation research. This fellowship provides a nine-month stipend, full tuition and fee scholarships, a $2,000 travel allowance, and Duke student medical insurance.

Predissertation and Dissertation Research Travel Awards. The Graduate School Predissertation and Dissertation Research Travel Awards provide funding for PhD students to travel outside the continental United States in order to conduct dissertation research. Award amounts vary from $500 to $3,000 depending on the research project and the number of proposals funded. Twenty-nine students received this award for travel in the 2014-15 academic year with an average award of approximately $2,400. Funding generally includes travel costs and direct research expenses. All students enrolled full-time in a graduate school program at Duke are eligible.

Organization for Tropical Studies. 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). Proposals are accepted twice each academic year. OTS provides limited funding to cover the cost of station fees and partial travel expenses for graduate students participating in this research program in Costa Rica. For more information on this opportunity, visit the OTS website.

Exchange Programs. The Graduate School has developed exchange programs with a number of foreign universities, including the Free University of Berlin, Potsdam University, Humboldt University, The Technical Institute of Berlin, the University of Salzburg, University of Venice, University of Vienna, the University of Erlangen-Nuremberg, and Meijii University in Japan.

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 website 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 capability and academic promise, typically replace departmental or The Graduate School fellowship awards.
Payment and Taxation 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 US 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 website. 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 United States. Information concerning tax treaties by country can be found on the Internal Revenue Service website. 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.

Financial Aid

For students pursuing a master's degree in The Graduate School, some limited funds for tuition scholarships may be available. These are awarded by the individual departments and programs. Master's students who are US citizens are also eligible for federal financial aid and work study. Master's applicants should indicate their need for financial support on their application for admission, and US citizens should complete the online Free Application for Federal Student Aid.

Graduate students are required to make satisfactory academic progress in their programs in order to remain enrolled in The Graduate School and to receive financial aid.

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. In order for The 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 US 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. 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, The Graduate School, Duke University, Durham, NC 27708-0061 or grad-finaid@duke.edu.

Work-Study Program Employment

Limited 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. Students considering the possibility of work-study for the fall should submit FAFSA forms by April 15. 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 maintains a listing of employment opportunities for students.
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 associate dean of academic affairs. 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 associate dean notice of this intention two months before the first day of the semester of their return.
Doctoral Students

Doctoral students must register for a total of six semesters of full tuition. For PhD students, approved transfer of an earned graduate degree may reduce the number of semesters of full tuition required for the degree to five semesters. After the six semesters of full 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. These milestone examinations may occur during breaks between terms for students registered in the term immediately before and immediately after the break.

Master's Students

Full-time master's candidates must register for at least nine units per semester until a minimum of thirty units of degree credit have been achieved (some programs require more than thirty units to obtain a degree). Full-time students can enroll for fewer than nine 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 coursework into a master's program will not reduce the minimum registration of thirty 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. The thesis examination may occur between terms if the student is registered for both the term before and after the break when the exam occurs.

Registration Periods

All students who are enrolled in The Graduate School and who have not been granted a leave of absence by the associate 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 Office of the University Registrar) 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 to any student registering late, including a current student who delays registering until the registration date for new students.

Auditing Courses

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 to audit the class. If the student is not in full-time status, an audit fee is charged.

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 their 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. PhD students who are conducting sponsored research related to their degree and/or are receiving support through university fellowships during the summer session, but are not enrolled in any courses, should be registered for summer but are charged a reduced tuition.

The university does not mail statements for summer session tuition and fees. All tuition and fees should be paid in the bursar's office at least five full working days prior to the first day of class (see summer session calendar on page 8). 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. There is a fee associated with auditing courses during the summer session.
General Academic Regulations

Credits

The following regulations pertain to credits earned outside of The 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 thirty units for a master's degree at Duke. For PhD students, up to 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 may consider previous coursework in determining further course requirements for the student—academic credit is distinct from financial credit or registration requirements for the PhD degree.

Grades and Academic Standing

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 and a permanent grade recorded. 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 nondegree 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 dismissal from a student’s degree program. In order to be certified as making satisfactory progress toward the degree, and in order to receive their degrees, graduate students must maintain at least a 3.0 (B) cumulative grade point average. Students falling below this average will be placed on academic probation. To remain in good academic standing in a program, a student must also demonstrate satisfactory progress in research and related activities beyond coursework, as certified by the student’s director of graduate studies. Degree programs may establish additional criteria that students must meet to remain in good academic standing. A failure to attain good academic standing, for whatever reason, results in probation for one semester. Two consecutive semesters on academic probation will normally trigger academic withdrawal from the university. The university reserves the right to request the withdrawal of any student whose academic performance at any time is not satisfactory to the university. Matriculation by the student is a concession to this right.

Reciprocal or Interinstitutional Agreements with In-State Universities

Under a plan of cooperation between Duke University and The University of North Carolina at Chapel Hill, North Carolina Central University, North Carolina State University, The University of North Carolina-Greensboro, and The University of North Carolina-Charlotte, 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 coursework 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 three units of credit at the home institution and three units of credit at the other institution, for a total of six units. All interinstitutional 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 inter-university joint degree programs or 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 200 level or above) that may be counted for credit; 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 49. 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 59). Failure to meet these requirements may result in summary dismissal by the associate dean of The Graduate School. 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. International students on visas should be aware that withdrawal has immediate implications for their legal status in the United States and should contact Visa Services for guidance. 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 41.

After successful completion of at least one semester of graduate study, a student who 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 conditions, full-time employment, receipt of an external award, or other acceptable reasons as judged by the associate dean of The Graduate School. 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 associate 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 in good academic standing. Time limitations that pertain to the various degrees and requirements, 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. Foreign students on visas should consult visa services for the implications of a leave of absence on their legal status in this country.

English Proficiency for International Students
All international students whose first language is not English must enroll in appropriate sections of English for International Students (EIS) during their initial year at Duke, unless formally waived from this requirement by The Graduate School upon certification of competency in English. The determination and assignment of the necessary course sections is by the EIS staff based on test results. These courses should be taken as early as possible in the student’s course of study at Duke. Completion of such courses is a requirement for graduation.
Library Privileges
Graduate students have full library privileges and 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 Student 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.

Degree Regulations: The Master’s Degrees

Master 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 course credits—ordinarily 12 course credits of approved college courses in the major subject and 12 course credits in the major or in related work. Since some departments require more than 12 course credits in the proposed field of study, students should read carefully the special requirements listed by their major departments in the chapter on “Departments, Programs, and Course Offerings” on page 66.” 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 “Departments, Programs, and Course Offerings” on page 66.”

Major and Related Subjects
Thirty course credits at Duke constitutes minimum enrollment for the completion of master of arts and the master of science degrees. Students must present acceptable grades for a minimum of 24 course credits of graded coursework, twelve of which must be in the major subject. Six course credits of the required twenty-four 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 in lieu of the thesis as previously approved by The Graduate School for a given degree program (see requirements listed in the chapter on “Departments, Programs, and Course Offerings” on page 66). In either case, a maximum of 6 course credits may be earned by the completion exercises and the final examination.

Thesis Requirements
The master’s 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 for the disciplinary field and should exhibit the student’s competence in scholarly procedures. Requirements of form are set forth in the Duke University Guide for Electronic Submission of Thesis and Dissertations, which is available on The Graduate School/Academics/These & Dissertations website. The dissertation advisor must examine and approve the master’s thesis prior to submission to The Graduate School, as indicated by a letter stating this approval. The thesis must be submitted electronically in an approved form to UMI/ProQuest two weeks prior to defense (see deadlines for submission and defense posted on
The copies of the thesis will be distributed by the student to the several members of the examining committee (three or more). Deadlines for submission are posted on The Graduate School website and must be respected if the student wishes to receive the degree in the semester when the intention to graduate had been declared. If a student misses deadlines for completion of all requirements during a term, including submission of an approved and correctly formatted thesis document, then the student must register and pay for a subsequent term in which s/he will receive the degree. All master’s theses 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/Academics/These & Dissertations website for information about electronic submission and procedures for obtaining a copyright.

**The Examining Committee and the Examination**

In consultation with a student and his/her major advisor, the program or department’s director of graduate studies recommends an examining committee composed of at least three members of the Duke graduate faculty, one of whom is from a department other than the degree-granting department or program, or from a different research area within the department or program. The committee and its chair must be approved by the associate dean of The Graduate School at least thirty days before the student takes the final examination. A student must be registered in the term during which he or she takes the final examination. However, the examination may also occur during breaks between terms if the student is registered for the term on either side of the break when the exam is to occur.

Nonthesis 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 an examination card provided by The Graduate School office. Each member of the approved committee must participate in the examination and must vote as to whether the student passed or failed the exam. With the express approval of the associate dean in advance of the exam, committee members may be allowed to participate via teleconference or video conference as long as a majority of the committee is physically present for the exam and signs the exam card (remote members document their vote separately). 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 vote to extend to the student the privilege of taking the examination a second time in case of failure. The action of the committee is confirmed by the director of graduate studies, who also must sign the exam card, which must then be submitted to The Graduate School. If the student passes the examination, the signed card indicates completion of the final examination for the degree. If a thesis is presented, the committee members also sign the title page and abstract page of the thesis, which the candidate then returns to The Graduate School along with the signed exam card. Any required changes to the thesis must be incorporated in correct format and the final document successfully uploaded to UMI/ProQuest before the relevant deadline (see Guide for Electronic Submission of Thesis and Dissertations).

**Master of Arts in Teaching**

See page 221 for a description of the MAT degree.

**Master of Arts in Liberal Studies**

See page 216 for a description of the MALS program.

**Master of Fine Arts: Experimental and Documentary Studies**

See page 222 for a description of the MFA program.

**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 approved 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 course credits of graduate credit may be transferred for graduate courses completed at other schools. Such credits 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 course credits for a master’s degree at Duke, even though it may relieve the student of specific courses otherwise required by the major department. Requests for transfer should be submitted on the approved graduate school form.

**Training in Academic and Research Integrity**

Beginning in Fall 2013, incoming master’s students enrolled in all degree programs of The Graduate School must complete a training course in academic integrity and responsible conduct of research. This will consist of a four-hour session at the start of the term, offered by The Graduate School staff and associates. This training will be a requirement for graduation.

**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 course credits, (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 website. 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 six semesters of full-time tuition (or five if credit for previous graduate work has been approved), (2) major and related courses as determined by the degree program, (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 or program, 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 “Departments, Programs, and Course Offerings” on page 66 or contact the appropriate director of graduate studies.
English Language Proficiency

All international PhD students are subject to the requirement described above (see “English Proficiency for International Students” on page 53).

Responsible Conduct of Research

All doctoral students at Duke University are required to complete a series of training sessions in the Responsible Conduct of Research (RCR). These sessions 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 at a conference facility in Durham, as will students in nonmedical biological sciences, physical sciences, and engineering programs. All PhD students will subsequently attend a mandatory 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 website.

Committee to Supervise the Program of Study

As early in a student’s course of study as is practicable and not later than one month (thirty days) before the preliminary examination, the director of graduate studies in the major program or department will nominate for the approval of the associate 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 at least one from outside the department or from a clearly differentiated division within the department. This committee, with all members participating, will determine a program of study and administer the preliminary examination.

Progress Toward Degree

Beginning with their second year of study, all PhD students must file an annual progress report, prepared in consultation with their research advisor, to their director of graduate studies summarizing their progress toward 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. The director of graduate studies in turn prepares an annual summary report on the program’s students for the associate dean’s review. Failure on the part of a student to submit an annual progress report will jeopardize The Graduate School’s ability to certify satisfactory progress toward the degree and thus jeopardize both the student’s academic standing and eligibility for continued financial support.

Residence

The minimum residence requirement is one academic year of full-time physical presence at Duke’s campus in Durham, and one year of continuous registration in The Graduate School (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 associate 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 highly unusual circumstances (e.g. severe illness), extensions will not be granted beyond the middle of the fourth year. Note that leaves of absence do not delay this timetable.

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. Should the dissertation not be submitted and accepted within four years after the preliminary examination, the candidate may, with the approval of the committee and the director of graduate studies, petition the associate 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 will be withdrawn from candidacy. The student must then
The dissertation must be completed to the satisfaction of the professor who directs the dissertation (dissertation advisor), members of the student’s advisory committee, and the associate dean of The Graduate School. The dissertation advisor must examine and approve the dissertation prior to submission to The Graduate School, as indicated by a letter to The Graduate School stating this approval. An electronic copy of the approved dissertation must be uploaded to UMI/Proquest for review and approval by The Graduate School at least two weeks prior to the defense. Deadlines for dissertation submission are posted on The Graduate School website and must be respected if the student wishes to receive the degree in the semester when the intention to graduate has been formally declared; if the deadlines are missed, the student must reapply to graduate in a subsequent term and pay continuation fees accordingly. 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/Academics/These & Dissertations website for information about electronic submission and about procedures for obtaining a copyright, and the possibility of a temporary embargo before public accessibility. Abstracts are published in Dissertation Abstracts International.

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. A student must be registered during the term when he or she takes the final examination, although the examination may occur during the break between terms if the student is registered for the term on either side of the break.

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 preliminary examination may apply, with the unanimous consent of the supervisory committee and the associate dean of The Graduate School, for the privilege of a second examination to be taken between three and six 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 makes 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 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. The dissertation must include a scholarly introduction that sets the context and importance of the research questions addressed in the study, separate chapter(s) presenting the research itself, and a final overview chapter summarizing the findings and significance of the dissertation project. 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, students must apply for graduation electronically by following the appropriate procedure in their student record. This application should indicate the approved title of the dissertation and must 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 Submission of Thesis and Dissertations, which is available on The Graduate School/Academics/These & Dissertations website. The dissertation must be completed to the satisfaction of the professor who directs the dissertation (dissertation advisor), members of the student’s advisory committee, and the associate dean of The Graduate School. The dissertation advisor must examine and approve the dissertation prior to submission to The Graduate School, as indicated by a letter to The Graduate School stating this approval. An electronic copy of the approved dissertation must be uploaded to UMI/Proquest for review and approval by The Graduate School at least two weeks prior to the defense. Deadlines for dissertation submission are posted on The Graduate School website and must be respected if the student wishes to receive the degree in the semester when the intention to graduate has been formally declared; if the deadlines are missed, the student must reapply to graduate in a subsequent term and pay continuation fees accordingly. 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/Academics/These & Dissertations website for information about electronic submission and about procedures for obtaining a copyright, and the possibility of a temporary embargo before public accessibility. Abstracts are published in Dissertation Abstracts International.

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. A student must be registered during the term when he or she takes the final examination, although the examination may occur during the break between terms if the student is registered for the term on either side of the break.

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 that conducted the first examinations, 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 prior to the relevant deadline. A student must be registered during the term when he or she submits the final version of the dissertation.

Commencement and Diplomas

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 semester or by the end of a summer term receive diplomas dated December 30 or September 1, respectively. These students are encouraged to attend the May ceremonies, despite having already received their degrees. 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. Diplomas will not be issued until all balances due the bursar have been paid in full.

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 nonacademic 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.

Failure of a graduate student to adhere to the Duke Community Standard is likely to result in dismissal from Duke University. 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 University, and false accusations of misconduct by others.
2. **Cheating:** A dishonest or unfair action to advantage an individual’s academic work or research. Such dishonesty would include the falsification of data, representing someone else’s work as your own, 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 NC 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**

The Graduate School is committed to a fair hearing and resolution of any student grievance. Graduate students with grievances should consult their director of graduate studies (DGS), who can inform them of the appropriate channels to address a student grievance. In normal circumstances, the DGS is the first to hear the substance of a complaint. If the complaint cannot be resolved satisfactorily at this level, or if the student is not comfortable discussing the grievance with the DGS, the student may ask the grievance be considered by the program chair, or by a faculty committee within the program appointed by the chair. Students or program faculty who are unable to resolve grievances at the level of the degree program may contact the relevant associate dean of The Graduate School (http://gradschool.duke.edu/about/staff/index.php). For academic matters, the contact is the Associate Dean for Academic Affairs. For financial concerns, the contact is the associate dean for finance and administration. For grievances related to student life, the contact is the associate dean for graduate student affairs. The associate dean will consider all the evidence and circumstances as well as interview the student with the grievance, and ultimately make a decision to resolve the grievance. If necessary, the student may ask for the grievance to be considered by the dean of The Graduate School, who shall be the final avenue of appeal. Any grievance or 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. The director of graduate studies will inform the relevant associate dean of any student grievances and their resolution in the annual report of the program. The deans will keep confidential records of all student grievances filed with them, the process by which they were considered, and their resolution.
Judicial Code and Appeals Procedure

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 some way unacceptable or detrimental to the university. However, a student’s position of responsibility to the authorities and the regulations of the university in no way alters or modifies responsibilities in relation to civil authorities and laws.

B. A graduate student at Duke University stands in a primary and unique relation of responsibility to the faculty in the major department, the faculty upon whose recommendation a graduate degree will or will not be awarded to the student. In matters which involve or may affect the student’s intellectual or professional life, the student is directly responsible to this department and its representatives, and such matters should primarily be handled by the department.

C. Actions which appear to conflict with university-wide rules and regulations will fall under the jurisdiction of the University Judicial Board.

D. At the final level of appeal, a student may elect to have the dean of The Graduate School hear matters related to the student’s conduct or may elect to have such matters reviewed and judged by a Judicial Board of faculty and students appointed by the dean of The Graduate School. (The constitution and procedure of the judicial board are detailed below.)

E. The director of graduate studies or the chair in the student’s major department may request that a student’s actions be reviewed by the Judicial Board or by the dean of The Graduate School.

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 chair. 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 the chair in the student’s department, by the dean of The Graduate School, or by the student.

B. Preliminary Procedures. If a student requests a hearing by the Judicial Board it must be done in writing, allowing its chair 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 chair 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 noti-
fied 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. However, any such a hearing must still operate within the context of federal regulations (FERPA: http://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html). 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 chair, 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. 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.

F. 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.

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.
Core Objectives

The core objectives at GSA are to assess student needs, build student support and resources, and identify, recruit, and retain a diverse student population. This is accomplished through comprehensive programming developed after evaluating students’ needs, partnering with student groups, and actively recruiting and preparing underrepresented students to be fully engaged as Duke graduate students. GSA staff combines these program components with innovative outreach, high levels of communication, and advocacy to enhance the quality of graduate student life.
Program Components

GSA hosts programs that mark students’ progress throughout their graduate careers.

- **New Student Orientation** aids students in their transition to Duke by providing crucial information about the academic community, policies, and resources.
- **The Graduate Student Information Session** takes place during New Student Orientation and features representatives from various university offices and Durham businesses.
- **A Milestone Recognition Reception** for PhD candidates honors those who pass preliminary examinations each year.
- During Commencement weekend, GSA hosts the PhD Hooding Ceremony and Reception, which celebrates the culmination of doctoral study.

Academic and Professional Development Programs

Graduate Student Affairs cooperates with other campus groups and offices to cosponsor many events that contribute to the professional development of graduate students, such as career exploration workshops co-sponsored by the Career Center and the Office for Postdoctoral Services, presentation skills workshops, and research presentation opportunities. The Graduate School cultivates a culture of good mentoring practices essential to students’ professional development by highlighting the recipients of the Dean’s Awards for Excellence in Mentoring and their accomplishments at a reception held during the spring semester. Professional development events are also included as part of Graduate Student Appreciation Week. All of these opportunities are posted on The Graduate School website, and announced in e-mail messages from GSA staff.

Social Programs

GSA coordinates activities designed specifically to encourage social interaction among graduate students. Several events during New Student Orientation help new students become acquainted with fellow students and Duke faculty. Graduate Student Appreciation Week recognizes graduate students’ contributions to Duke’s academic climate with a roster of enjoyable social events and practical workshops on student life issues. To provide regular networking opportunities for graduate students with children, GSA also hosts several Family Fun Fairs each year.

Diversity Initiatives

The Graduate School has a long-standing commitment to increasing the diversity and quality of its graduate student body. Our primary goals are to increase the enrollment of students from underrepresented groups, to provide underrepresented students with sufficient funding to complete their graduate studies in a timely manner, and to promote an academic and social environment where all scholars can flourish.

A key mission of the Office of Graduate Student Affairs is to coordinate, supplement, and expand the recruiting efforts of graduate departments and programs. Aggressive, targeted recruiting strategies are vital to these efforts, and the involvement of Duke’s graduate faculty is central to these strategies. Each year, GSA participates in recruitment fairs across the country that enable us to meet potential graduate students and to answer any questions they might have about Duke’s graduate programs. Other mechanisms The Graduate School employs in the recruitment of students from underrepresented groups include participation in national consortia designed to promote graduate education and targeted recruitment visits to institutions that serve students from historically underrepresented groups. GSA also supports a summer research opportunities program that identifies potential graduate students early in their college careers.

Program Support

GSA’s programs are developed, supported, and enhanced through four program support elements: advocacy, communications, student group support, and program evaluation. These elements ensure that GSA develops its programs and resources in such a way that they are accessible, inviting, and responsive to the needs of all segments of the graduate community.
Advocacy

Graduate Student Affairs makes every attempt to assess and to respond to the concerns of Duke graduate students. The Child Care Subsidy, Childbirth and Adoption Accommodation Policy, and efforts to recognize and promote best practices in graduate student mentoring are examples of initiatives that arose from GSA's response to students' expressed needs and concerns. In many instances, GSA is the initial point of contact for graduate students, offering informal counseling and advising.

Furthermore, GSA acts as the liaison between The Graduate School and the Career Center; Counseling and Psychological Services; the Office for Institutional Equity; the Student Disability Access Office; the central university Office of Student Affairs; and other campus offices. The Office of Graduate Student Affairs works to create linkages with Duke's graduate departments and the university administration. In addition, GSA representatives are members of national committees, graduate consortia, and professional associations concerned with issues related to graduate student life.

Communications

GSA works to enhance communication within the graduate community. GSA staff members serve on a variety of committees that explore and evaluate new models of communication with students. Targeted e-mail announcements and Facebook postings keep students informed about GSA events and other university programs. The Graduate School Newsletter highlights particular student issues, features student profiles, and identifies university resources.

Student Group Support

Graduate Student Affairs advises and assists graduate student organizations. These groups help GSA to invest a portion of its time and resources in programming that addresses the specific needs of many important segments of the graduate community.

Program Evaluation

Developing formal and informal mechanisms for program evaluation is crucial in assessing the effectiveness of GSA services and in instituting new programs. Formal evaluation of GSA's programs are carried out through surveys of major activities, followed by analysis and progress reports. Assessment of GSA's effectiveness is also supported by collaborating with The Graduate School Office of Finance and the Office of Admissions to track students throughout the admissions process and to prepare retention data. Informal evaluations of GSA events are conducted with individual students, student groups, and graduate faculty. Additionally, GSA regularly seeks feedback from its Graduate Student Affairs Advisory Committee (GSAAC). Composed of faculty, students, and staff representing each broad disciplinary area in the

The Graduate School, GSAAC's role is to serve as an evaluative resource in program development and to help in adopting specific strategies to meet program goals.
Course Enrollment

Courses numbered 500-699 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 700. 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 more than thirty graduate 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 proven 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. These certificates are not standalone and cannot be earned independent of the student’s degree. (Additional information for each certificate program is available on the certificate’s website.)

Further descriptions, information, and requirements for all certificate programs are to be found in this chapter. 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
- College Teaching
- Computational Biology and Bioinformatics
- Developmental Psychology
- Developmental and Stem Cell Biology
- East Asian Studies
- Ecology
- Genetics and Genomics
- Global Health
- History and Philosophy of Science, Technology, and Medicine
- Information Sciences and Information Studies
- Integrated Toxicology and Environmental Health Program (University Program in Environmental Health)
- Interdisciplinary European Studies
- Interdisciplinary Medieval and Renaissance Studies
- Latin American and Caribbean Studies
- Middle East Studies
- Nanoscience
- Nonlinear and Complex Systems
- Philosophy, Arts, and Literature
- Philosophy of Biology
- Photonics
- Slavic, Eurasian, and East European Studies
- Structural Biology and Biophysics
- Women’s Studies
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.
- **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.
- **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.
- **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 micro-economics course in economics. The most preferred course is Economics 302 depending on the applicant’s objectives (e.g., Political Science 243, Psychology 349/350, Sociology 302, or Business Administration 513).
- **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, Political Science 233, Psychology 274, and Sociology 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 Program for Advanced Research in the Social Sciences capstone course.

For additional information visit the program’s website at [http://www.ssri.duke.edu/](http://www.ssri.duke.edu/).

African and African American Studies

Professor DeFrantz, Chair; Professor of the Practice, Smith, Director of Undergraduate Studies; Associate Professor Wallace, Director of Graduate Studies; Professors Baker, Bonilla-Silva, Burton, Crichlow, Darity, DeFrantz, Dubois, French, Harris, Holloway, James, Matory, Neal, Piot, Powell and Whirtield; Associate Professors Glymph, Hall, Haynie, Holsey, Lubiano, Milian, Royal, and Wallace; Assistant Professors Aidoo and Makhulu; Professor of the Practice Smith; Associate Professor of the Practice Shapiro.

A certificate is available in this program.

The Department of African and African American Studies (AAAS) offers a certificate in African and African American studies. Students enrolled in doctoral and master’s programs 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 AAAS-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 thought and 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. Graduate students enrolled in the program are encouraged to participate in all African and African American studies events, and to audit the lecture series and symposia.

For further information regarding application and enrollment in the graduate certificate program in African and African American studies, contact the department’s director of graduate studies or visit http://aaas.duke.edu/graduate-certificate.

Requirements for PhD Students:
• Must take the gateway graduate seminar.
• Must take three additional graduate-level courses, two of which must be taught by AAAS core faculty. The third course must originate in, or be cross-listed with African and African American studies.
• Must either complete a teaching assistantship (or instructorship) in an AAAS-related undergraduate course under the sponsorship/supervision of an AAAS core or secondary faculty member; or take a fifth course, approved by the director of graduate studies, and submit a course proposal with syllabus for a related African and African American studies undergraduate course. In this case, the proposal and syllabus must be submitted prior to the dissertation defense and approved by an AAAS core faculty member.
• Write a dissertation in an African and African American studies area with core or secondary faculty represented on the dissertation committee.

Requirements for Master’s Students:
• Must take the gateway graduate seminar.
• Must take two additional graduate-level courses taught by core or secondary faculty.
• Must complete an independent study (MALS students may complete Liberal Studies 375) developed in association with an AAAS core or secondary faculty member.
• A final thesis/project (MALS students may complete Liberal Studies 850), approved in advance by the AAAS director of graduate studies, that addresses an aspect of the program’s scholarly mission. An AAAS faculty member must serve as a final reader of the thesis/project, or as an examiner in its final review.

Courses in African and African American Studies (AAAS)

510S. Africa in a Global Age. 3 units. C-L: see Cultural Anthropology 561S; also C-L: History 561S, Political Science 527S, International Comparative Studies 510S

515S. Race, Class, and Gender: A Social History of Modern (1750-present) Britain. 3 units. C-L: see History 505S; also C-L: Women's Studies 509S

520S. Harlem Renaissance. 3 units. C-L: see Art History 554S

530S. Third Cinema. 3 units. C-L: see Literature 613S; also C-L: International Comparative Studies 613S, Latin American Studies 613S, Arts of the Moving Image 644S

540S. Seminar in Asian and Middle Eastern Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 505S; also C-L: Literature 530S

541S. Monuments and Memory: Public Policy and Remembrance of Racial Histories. 3 units. C-L: see Public Policy Studies 562S

544S. Race and American Politics. 3 units. C-L: see Political Science 525S; also C-L: Public Policy Studies 526S

545S. Race, Racism, and Democracy. 3 units. C-L: see Cultural Anthropology 535S

548S. Poverty, Inequality, and Health. 3 units. C-L: see Public Policy Studies 644S

549S. Schooling and Social Stratification. 3 units. C-L: see Public Policy Studies 542S; also C-L: Education 542S

551S. Race and Ethnicity. 3 units. C-L: see Public Policy Studies 529S; also C-L: International Comparative Studies 529S

575. Justice, Law, and Commerce in Islam. 3 units. C-L: see Religion 660; also C-L: Medieval and Renaissance Studies 659

580S. Race Theory: Biological Classification and Moral Implications. 3 units. C-L: see Philosophy 539S

589S. Black Visual Theory. 3 units. C-L: see Visual and Media Studies 555S

590S-5. Topics in African Art. 3 units. C-L: see Art History 590S-5
594S. Cultural (Con)Fusions of Asians and Africans. This course examines how people lay claims to belonging as citizens of nation-states. Focusing primarily on African and Indian descended populations in the Caribbean and the Pacific, we investigate how these populations invoke colonial constructions to reinvent themselves and work to negotiate their racialized identities in these shared communities. We will consider the construction of histories and explore the general cultural politics that sustain and bolster claims of authenticity and belonging and unbelonging within these national spaces. What sorts of sociocultural and political strategies are deployed by such people to exclude others even as they connect across these troubling divides. Instructor: Crichlow. 3 units. C-L: Cultural Anthropology 594S, Latin American Studies 594S, Sociology 594S

620S. AfroFuturism. Explores Afrofuturism, a literary and cultural aesthetic imagining how people of color project themselves into narratives of the future. Investigation of Science fiction, fantasy literature, music, artworks, music videos, and dance to trace the concept of an Afrofuturist point of view. Creation of Afrofuturist media and performances. Artists considered include writers Samuel R. Delany and Andrea Hairston; musicians Parliament-Funkadelic and Sun Ra; filmmaker Hype Williams; performers Janelle Monae and Flying Lotus. Instructor: DeFrantz. 3 units. C-L: Dance 535S, Theater Studies 535S, Visual and Media Studies 524S

621S. Black Performance Theory. Exploration of methods and research approaches relevant to the construction of black performance theory. Performance Studies methodologies undergird ways of seeing and modes of analysis relevant to considerations of black art, including dance, sound and music, drama, visual art, and aesthetics of popular culture. Instructor consent required. Instructor: DeFrantz. 3 units. C-L: Dance 645S, Visual and Media Studies 621S

641S. Citizen and Subject in a Neoliberal Age. Explores studies of citizenship, quests to belong to a place, and institutional mechanisms people deem sacred, and others, profane and dispensable. Focuses on the ways African, Caribbean and Pacific peoples have adapted identitarian constructions to develop narratives of home. Case studies using ethnographic, historical, sociological and visual methods are used to investigate how particular claims are pursued in clamoring for citizenship in various communities. Instructor: Crichlow. 3 units. C-L: Sociology 645S, Cultural Anthropology 641S

642S. Global Inequality Research Seminar. Engagement of vertically integrated research teams in projects exploring racial and ethnic disparities exhibited and expressed in six arenas: employment, wealth, health, political participation, education, and arts and culture. Each team will produce a major paper that will qualify for submission to a refereed journal in the area relevant to the focus of the study. Instructor: Staff. 3 units. C-L: Economics 541S, Sociology 642S, Political Science 642S, Public Policy Studies 645S

645S. African Modernities. Encounters between African societies and global forces, including colonialism, capitalism, development initiatives. Instructor: Holsey. 3 units. C-L: Cultural Anthropology 560S

690. Special Topics. Topics vary from semester to semester. Instructor: Staff. 3 units.

690S. Special Topics. Seminar version of African and African American Studies 299. Instructor: Staff. 3 units. C-L: Genome Sciences and Policy 590S-01

699S. Gateway/Proseminar. The proseminar is the required gateway course in the AAAS Certificate Program. It is designed to introduce students to the broad interdisciplinary scope of advanced scholarship in black diasporic studies globally. Students will learn interdisciplinary and cross disciplinary research methods, including awareness of archival, bibliographic, and qualitative/quantitative methods. The history of the field and its unique influence on the production of humanistic and social scientific knowledge are also significant concerns in the course. Instructor: Staff. 3 units.

740S. Racial and Ethnic Minorities in American Politics. 3 units. C-L: see Political Science 703S; also C-L: Public Policy Studies 845S

741S. Globalization. 3 units. C-L: see Cultural Anthropology 741S

780S. Teaching Race, Teaching Gender. Interdisciplinary analyses of the problematics of teaching about social hierarchies, especially those of race, class, and gender. Curricular content and its interaction with the social constructions of students and teachers. Instructor: Lubiano. 3 units. C-L: Women's Studies 780S, History 780S, Literature 780S

890. Special Topics. Topics vary from semester to semester. Instructor: Staff. 3 units.

891. Special Readings. Consent of instructor required. Instructor: Staff. 3 units.
Anthropology and History
Professor Reddy, Codirector of Graduate Studies; Professor Silverblatt, Codirector 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 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 extension 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 cross-listed 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:

- Completion of a core graduate seminar:
  - with two-semester sequence beginning with History 210S/Cultural Anthropology 207S (Anthropology and History); and
  - concluding with—research seminar in which students prepare and present their own papers.
- Participation (while in residence) in an anthropology and history colloquium to be organized by the affiliated faculty and the students.
- One presentation of the student’s own work at the colloquium, usually during the writing phase of the dissertation.
- At least two other courses in the nondegree department.
- Capstone research paper (if in history, this may be a part of the student’s portfolio).
- Preliminary examination field in the nondegree 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 & Visual Studies
Professor Dillon, Chair; Assistant Professor Galletti, Director of Graduate Studies; Professors Antliff, Bruzelius, Dillon, Forte, Hansen, Leighton, Lenoir, McWilliam Morgan, Noland, Powell, Rankin, Seaman, Shatzman, Stiles, Van Miegroet, Weisenfeld, and Wharton; Associate Professors Abe, Gabara, and Lasch; Assistant Professors Galletti, Olson, Salvatella, and Szabo

A PhD is available in this department.

The Department of Art, Art History & Visual Studies offers graduate work leading to the PhD degrees in art history and in visual and media studies. The doctoral program is competitive with the leading 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 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. Coursework 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.

For further information on the PhD program, prospective applicants may visit the department’s website at http://aahvs.duke.edu, or write to the director of graduate studies.

The department also offers a Master's Degree in Historical and Cultural Visualization. The 18-month program integrates historical disciplines and the study of cultural artifacts with digital visualization techniques for the analysis and presentation of research. The program requires 10 courses over three semesters in addition to summer research. Students affiliate with an existing faculty research initiative, from which they will develop their own independent research project for the M.A. thesis. Common themes that unite the various projects are the visualization of process, the representation of change over time, recontextualizing displaced objects and object biographies.

The department also participates in a program with the Duke Law School leading to a joint JD/MA degree, and has a joint MFA in experimental and documentary arts in collaboration with the Center for Documentary Studies and the program in the Arts of the Moving Image. 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 visit the departmental website at http://aahvs.duke.edu/graduate/jd-ma. For information on the MFA in experimental and documentary arts, please visit http://aahvs.duke.edu/graduate/mfa.

Courses in Art History (ARTHIST)

501S. 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

502S. Greek Art: Hellenistic to Roman. Seminar explores art of Greek East from 300 B.C.E to 300 C.E; emphasis on understanding and analyzing production, style, materials, functions. Sculpture made for Hellenistic kings and cities, and changes in sculptural production with Roman conquest and imperial rule. Main categories of evidence: funerary monuments, portrait statues, heroic groups in baroque style, Dionysiac-themed decorative sculpture. Issues of stylistic categories, periodization, meaning and interpretation, theoretical perspectives expressed in ancient literary texts, and current scholarly debates and trends in study of Hellenistic and Roman art in a Greek context form an integral part of the seminar. Instructor: Dillon. 3 units. C-L: Classical Studies 542S
506A. 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 262A-263A. Course credit contingent upon completion of Art History 507A. Instructor: Van Miegroet. 3 units. C-L: Medieval and Renaissance Studies 504A, Visual and Media Studies 506A


536S. Technology and New Media: Academic Practice. 3 units. C-L: Visual and Media Studies 562S

537S. Critical Studies in New Media. 3 units. C-L: Literature 621S, Visual and Media Studies 561S

538S. 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: Staff. 3 units.

540S. 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. Instructors: Antliff, Leighten, or McWilliam. 3 units.

541S. The Symbolist Movement in the Arts & European Thought. Investigates the relationship linking Symbolist aesthetics and practice with currents in European philosophy in the late nineteenth and early twentieth centuries. The reaction against Positivism; aesthetic idealism and the Platonic tradition; the influence of Schopenhauer and Nietzsche on artists and writers; Symbolism and mysticism (Theosophy, Rosicrucianism, the occult); Symbolism and the Catholic revival; Art nouveau and theories of psychology; the anarchist impulse. Emphasis on visual arts in France, England and Germany; focus on the relationship between word and image in Symbolist poetics. McWilliam. 3 units. C-L: Literature 541S

542S. Information Archeology: Studies in the Nature of Information and Artifact in the Digital Environment. 3 units. C-L: see Information Science and Information Studies 680S; also C-L: Visual and Media Studies 569S

543S. 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.

544S. Soviet Art after Stalin 1956-1991. 3 units. C-L: see Russian 561S

546S. The American Artist. This course utilizes art historical methodologies as tools for critical inquiry and scholarly research on one American artist (selected as per this seminar's scheduling every four years). Apart from a firm biographical and art historical grasp of the specific American artist under investigation, the goal of this course is to develop visual literacy of American art through seeing and writing. An emphasis will be placed on improving various forms of written art discourse (i.e., descriptive, expository, interpretative, etc. Instructor: staff. 3 units.

551LS. 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
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. Instructors: Bruzelius, Dillon, Olson, or Szabo. 3 units. C-L: Visual and Media Studies 551LS, Information Science and Information Studies 551LS

554S. 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. Instructor: Powell. 3 units. C-L: African and African American Studies 520S

557S. 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. C-L: Visual and Media Studies 557S

558S. Spatial Practices. How space works from medieval refectories to Starbucks, from Jerusalem to Las Vegas, from mikvaot 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. Instructor: Wharton. 3 units.

560SL. Roman Topography: Urban Life and Cityscapes in Ancient Rome. 1 unit. C-L: see Classical Studies 556SL; also C-L: Visual and Media Studies 570SL

561. Etruscan Cities. 3 units. C-L: see Classical Studies 560

589S. Critical Animal Studies in Art and Visual Culture. The visual culture constructed around animals, including images of animals from prehistoric to contemporary representations, the role of visualization in animal rights and survival, animals as human totems and stuffed toys, portrayals of animal consciousness and debates about speciesism, in the analysis of the cultural objectification and societal subjectification of animals. Instructor: Stiles. 3 units.

590S. Special Topics. Subjects, areas, or themes that embrace a range of disciplines or art historical areas. Instructor: Staff. 3 units.

590S-01. Special Topics in Greek Art. Problems and issues in a specific period or genre of Greek material culture. Instructor consent required. Instructor: Dillon. 3 units. C-L: Classical Studies 590

590S-10. Special Topics in Roman Archaeology. 3 units. C-L: see Classical Studies 590LS

590S-11. Special Topics in Greek Archaeology. 3 units. C-L: see Classical Studies 590SL-1

590S-2. Topics in Renaissance Studies. 3 units. C-L: see Italian 590S-1; also C-L: Medieval and Renaissance Studies 690S-2

590S-3. 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 590S-1

590S-4. 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: Galletti. 3 units. C-L: Medieval and Renaissance Studies 590S-2

590S-5. 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 590S-5

590S-6. 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.
590S-7. 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.

590S-8. 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.

590S-9. 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.

630S. Phenomenology and Media. 3 units. C-L: see Literature 630S; also C-L: Information Science and Information Studies 630S, Visual and Media Studies 630S, Arts of the Moving Image 631S

632S. Whitehead, Bergson, James. 3 units. C-L: see Literature 632S; also C-L: Information Science and Information Studies 632S, Visual and Media Studies 632S, Arts of the Moving Image 632S

700S. 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.

701S. 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.

702S. 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.

703S. 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.

704S. 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.

705S. 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.

706S. 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.

707S. 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. Fergusson and the British fauvisins, 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.

708S. 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.

710S. 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, neocatholicism, 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.

711S. 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.

712S. 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.

713S. 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. C-L: Religion 881S

715S. 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.

716S. 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. C-L: East Asian Graduate Certificate

717S. 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.

718S. History of Conceptual Art. 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.

719S. 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 archi-
tecture 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.

720S. 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.

721S. Spatial Practices. Space, once a vacuum in which action took place, is now broadly acknowledged as a formidably 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.

722S. Curatorial Practices in a Global Context. History and critical theories of all experimental art from conceptual, performance, and installation to video and multimedia, collectives, and ecological and bioart considered in a global context including international exhibitions, biennials, and new curatorial practices. Instructor: Stiles. 3 units. C-L: Visual and Media Studies 722S

723S. Grant Writing and Prospectus. Focuses on the development of the dissertation research proposal and the preparation of grant proposals. Instructor: Leighten. 3 units.

743S. Anthropology of Media and Mediation. 3 units. C-L: see Cultural Anthropology 743S; also C-L: Visual and Media Studies 743S

782. Art and Dissidence: Films of Tarkovsky, Kubrick, Kurosawa, and Lynch. 3 units. C-L: see Russian 782

790. 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.

790-1. 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.

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

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

844. Protestants and Pictures. 3 units. C-L: see Religion 844

911. Religious Material Culture in Theory and Practice. 3 units. C-L: see Religion 911

Courses in Visual Arts (ARTSVIS)

510S. (Neosentience) Body as Electrochemical Computer. 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 and Media Studies 510S, Information Science and Information Studies 666S, Arts of the Moving Image 622S

515S. Representing Architecture: Means and Methods. Projects and skills based studio course. Exploration of the historic and contemporary techniques and technologies used to visualize, communicate and document, built/historic, proposed or hypothesized architecture and its construction. Focus on its application for art, architectural history and the humanities, as well as architectural design training. Topics covered include hand sketching, ortho/perspective representation, 2d CAD, 3d modeling and potential explorations of 3d immersion/VR or 3d printing/model-making. Presented in a series of short, topic-based studio exercises culminating in a final project, which may relate to the student's research interests. Instructor consent required. Instructor: Berreth. 3 units. C-L: Art History 515S, Historical and Cultural Visualization 515S
554S. 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. Consent of instructor required. 3 units. C-L: Visual and Media Studies 554S, Sociology 636S

556S. Poverty and the Visual. Relationship between art, visual culture, and poverty from 1950s to present across cultures. Readings across broad range of texts in humanities and social sciences. Research, visual analyses, and student productions based on a broader understanding of poverty as a philosophical, economic, social, and cultural concept. Three-part definition of poverty includes: special focus on cultural contributions of grassroots social movements and impoverished sectors of global society, poverty as an intentional set of aesthetic or cultural constraints, and poverty as a critical term to understand historical and contemporary limitations of visuality. Instructor consent required. Instructor: Lasch. 3 units. C-L: Visual and Media Studies 570S, Sociology 556S

599. Bookmaking: The Hand Printed Book. Using printmaking and photography as a vehicle for the development of imagery, students will focus on the creation of a hand printed artist book throughout the semester. Information driving the imagery and/or text will be researched and displayed in bound, editioned copies of their book at the end of the semester. Prior bookmaking and printmaking coursework/experience is required, in addition to knowledge of Adobe Photoshop and Illustrator. Instructor consent required. Instructor: Shatzman. 3 units.

630. The Ongoing Moment: Presentations of Time in Still and Moving Images. Project-driven studio course exploring time through video and still photography. Management, presentation and trace of time discussed in relation to various forms of art, augmented by examination of concepts of duration, aura, silence and thought as they pertain to still and moving images. Individual and group projects investigate various manifestations of stillness and movement in video and photography, with and without sound. Slices of time in both media examined for their properties of continuity, discontinuity and fissure, with emphasis on rendering meaning in and through time and space. Instructor consent required. Prerequisites: two 200-level or above photography or film production classes. Instructor consent required. Instructor: Noland. 3 units. C-L: Arts of the Moving Image 630

655S. The Photographic Portfolio. Students identify photographic territory to explore and build a body of work. Images are extensively work-shopped for sequencing. Particular emphasis on the making of high quality prints. Semester culminates in the production of finished portfolios in three formats: print, digital, and exhibition or installation. Student's body of work to be informed by relevant precedents from history of photography, with an emphasis on identifying bodies of photographic work that communicate something larger than a single idea. Instructor consent required; this is the same course as Visual Arts 455, with additional graduate level work required. Instructor: Noland. 3 units.


Courses in Historical and Cultural Visualization (HCVIS)

515S. Representing Architecture: Means and Methods. Projects and skills based studio course. Exploration of the historic and contemporary techniques and technologies used to visualize, communicate and document, built/historic, proposed or hypothesized architecture and its construction. Focus on its application for art, architectural history and the humanities, as well as architectural design training. Topics covered include hand sketching, ortho/perspective representation, 2d CAD, 3d modeling and potential explorations of 3d immersion/VR or 3d printing/model-making. Presented in a series of short, topic-based studio exercises culminating in a final project, which may relate to the student's research interests. Instructor consent required. Instructor: Berreth. 3 units. C-L: Visual Arts 515S, Art History 515S

580S. Historical and Cultural Visualization Proseminar 1. 2D and 3D imaging, modeling; raster and vector graphics sources, laser scanners, photogrammetric software, basic database structures. Digital mapping and GIS. Presentation strategies and best practices for the web (standards-compliant HTML/CSS/JavaScript), multimedia (audio/video/animation), scholarly annotation, intellectual property. Theoretical, ethical issues in field of new media and digital humanities. Epistemological issues re: mediation and visualization, ethics of intellectual property, politics.
of geospatial visualization, digital materiality, affordances of new media narrativity. Preference given to MA students in Historical and Cultural Visualization. Instructor consent required. Instructor: Olson or Szabo. 3 units. C-L: Visual and Media Studies 580S, Information Science and Information Studies 580S

581S. Historical and Cultural Visualization Proseminar 2. Interactivity and online content management through databases, collaborative blogs, and other systems. Data visualization based on textual, image, and quantitative sources. Basic techniques for virtual reality, simulations, augmented reality, and game-based historical and cultural visualization project development. Mini-projects based on existing and new research data from the Wired! Lab and elsewhere. Best practices for digital research project planning and collaboration. Theoretical topics include: critical digital heritage, virtuality and culture, information aesthetics, hypermedia information design. Instructor consent required. Historical and Cultural Visualization 580S required. Instructor: Olson or Szabo. 3 units. C-L: Visual and Media Studies 581S, Information Science and Information Studies 581S

Courses in Visual and Media Studies (VMS)

506A. 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 262A-263A. Course credit contingent upon completion of Art History 507A. Instructor: Van Miegroet. 3 units. C-L: Art History 506A, Medieval and Renaissance Studies 504A

507A. History of Netherlandish Art and Visual Culture in a European Context. Second half of Art History 506A-507A; required for credit for 506A. (Taught in the Netherlands.) Not open to students who have taken Art History 262A-263A. Instructor: Van Miegroet. 3 units. C-L: Art History 507A, Medieval and Renaissance Studies 505A

510S. (Neosentience) Body as Electrochemical Computer. 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 666S, Visual Arts 510S, Arts of the Moving Image 622S

515S. Interethnic Intimacies: Production and Consumption. 3 units. C-L: see Asian & Middle Eastern Studies 515S; also C-L: Literature 515S, Arts of the Moving Image 515S, International Comparative Studies 515S, Women's Studies 505S


535S. Camera Asia. Examines how art and technology of photography have changed the way we study and understand historical past, with focus on three important Asian contexts: China, India, and Japan. Analyzes arrival of photography in these places as a historical event, and the photographers and how their work was viewed. Evaluates ways in which technology was embraced, to what purposes was the art form put in terms of cultural representation, commercial development, industrialization, and nation building. Instructor: Weisenfeld and Ramaswamy. 3 units. C-L: History 530S, International Comparative Studies 531S

539S. Queer China. 3 units. C-L: see Asian & Middle Eastern Studies 539S; also C-L: Cultural Anthropology 539S, Women's Studies 502S, Literature 539S, Arts of the Moving Image 539S

550S. Digital Humanities: Theory and Practice. 3 units. C-L: see Information Science and Information Studies 560S

551LS. 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. Instructors: Bruzelius, Dillon, Olson, or Szabo. 3 units. C-L: Art History 551LS, Information Science and Information Studies 551LS

552. Citizen Godard. 3 units. C-L: see French 510; also C-L: Arts of the Moving Image 642, Literature 510

553S. 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. Instructor: McWilliam. 3 units.

554S. 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. Consent of instructor required. 3 units. C-L: Sociology 636S, Visual Arts 554S

555S. 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 589S

556S. 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. Instructor: Gabara. 3 units.

557S. 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. C-L: Art History 557S

559S. Urbanism. Introduction to urbanism through considerations of the political, social and economic forces that model urban space. Assessment of the expression in urban topography of state power, disempowered communities, competing ethnicities, religious groups. Readings include canonical works of urban history (Vitruvius, Jacobs), theory (Benjamin, Lefebvre), novels and media (Visconti, Zola). Instructor: Wharton. 3 units.

560S. 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.

561S. Critical Studies in New Media. 3 units. C-L: see Information Science and Information Studies 650S; also C-L: Literature 621S, Art History 537S

562S. Technology and New Media: Academic Practice. 3 units. C-L: see Information Science and Information Studies 540S; also C-L: Art History 536S

563. Media and Democracy. 3 units. C-L: see Public Policy Studies 674
565S. 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 ephemerality. 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 565S


570S. Poverty and the Visual. Relationship between art, visual culture, and poverty from 1950s to present across cultures. Readings across broad range of texts in humanities and social sciences. Research, visual analyses, and student productions based on a broader understanding of poverty as a philosophical, economic, social, and cultural concept. Three-part definition of poverty includes: special focus on cultural contributions of grassroots social movements and impoverished sectors of global society, poverty as an intentional set of aesthetic or cultural constraints, and poverty as a critical term to understand historical and contemporary limitations of visuality. Instructor consent required. Instructor: Lasch. 3 units. C-L: Visual Arts 556S, Sociology 556S

575S. Generative Media Authorship - Music, Text & Image. Covers Generative Media in all its forms. Lectures, workshops, discussions, one semester-length project, shorter individual exercises and readings. Interdisciplinary Graduate Seminar with advanced undergraduates and MFA students with permission of instructor. Instructor: Seaman and Supko. 3 units. C-L: Arts of the Moving Image 575S, Information Science and Information Studies 575S, Music 575S

580S. Historical and Cultural Visualization Proseminar 1. 2D and 3D imaging, modeling; raster and vector graphics sources, laser scanners, photogrammetric software, basic database structures. Digital mapping and GIS. Presentation strategies and best practices for the web (standards-compliant HTML/CSS/Javascript), multimedia (audio/video/animation), scholarly annotation, intellectual property. Theoretical, ethical issues in field of new media and digital humanities. Epistemological issues re: mediation and visualization, ethics of intellectual property, politics of geospatial visualization, digital materiality, affordances of new media narrativity. Preference given to MA students in Historical and Cultural Visualization. Instructor consent required. Instructor: Olson or Szabo. 3 units. C-L: Historical and Cultural Visualization 580S, Information Science and Information Studies 580S

581S. Historical and Cultural Visualization Proseminar 2. Interactivity and online content management through databases, collaborative blogs, and other systems. Data visualization based on textual, image, and quantitative sources. Basic techniques for virtual reality, simulations, augmented reality, and game-based historical and cultural visualization project development. Mini-projects based on existing and new research data from the Wired! Lab and elsewhere. Best practices for digital research project planning and collaboration. Theoretical topics include: critical digital heritage, virtuality and culture, information aesthetics, hypermedia information design. Instructor consent required. Historical and Cultural Visualization 580S required. Instructor: Olson or Szabo. 3 units. C-L: Historical and Cultural Visualization 581S, Information Science and Information Studies 581S

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

590S. Special Topics in Visual Studies. Subjects, areas, or themes that embrace a range of disciplines related to visual studies. Instructor: Staff. 3 units.

614S. Thinking Digital Cinema. 3 units. C-L: see Literature 614S; also C-L: Theater Studies 671S, Arts of the Moving Image 614S

615S. The #Selfie. 3 units. C-L: see Literature 615S; also C-L: Arts of the Moving Image 615S, Women's Studies 615S, International Comparative Studies 615S
621S. Black Performance Theory. 3 units. C-L: see African and African American Studies 621S; also C-L: Dance 645S

625S. Comparative Media Studies. 3 units. C-L: see Literature 625S; also C-L: Information Science and Information Studies 615S

630S. Phenomenology and Media. 3 units. C-L: see Literature 630S; also C-L: Art History 630S, Information Science and Information Studies 630S, Arts of the Moving Image 631S

631S. Seminar on Modern Chinese Cinema. 3 units. C-L: see Asian & Middle Eastern Studies 631S; also C-L: Arts of the Moving Image 633S, Literature 631S

662S. Mapping Culture: Geographies of Space, Mind, and Power. 3 units. C-L: see Information Science and Information Studies 662S

691. Independent Study. Directed reading in a field of special interest, under the supervision of a faculty member, resulting in a substantive paper or report. Consent of instructor and director of graduate studies required. Instructor: Staff. 3 units.

692. Independent Study. Directed reading in a field of special interest, under the supervision of a faculty member, resulting in a substantive paper or report. Consent of instructor and director of graduate studies required. Instructor: Staff. 3 units.

719S. Russian Language and Culture through Film II. 3 units. C-L: see Russian 774S

773S. Russian Language and Culture through Film. 3 units. C-L: see Russian 773S

Biochemistry

Professor Brennan, Chair (255 Nanaline H. Duke); Professor Spicer, Director of Graduate Studies (235 Nanaline H. Duke); Professors Been, Beece, Bennett, Beratan, Brennan, Casey, Donald, Erickson, Fitzgerald, Greenleaf, Hellinga, Kreuzer, Lefkowitz, Modrich, McCafferty, Newgard, Nicchitta, Oas, D. Richardson, J. Richardson, Simon, Spicer, Thiele, Toone; Associate Professors Kuehn, Schumacher, Zhou; Assistant Professors Hargrove, Lee, Rajagopol, Yokoyama; Professors Emeriti Fridovich, Gross, Hammes, Hershfield, Hsieh, Rajagopalan Sage, Siegel, Steege, and 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, dynamics, and function, lipid biochemistry, membrane structure and function, molecular genetics, and enzyme mechanisms. The recommended core requirements consist of mini-courses Biochemistry 658/659 and 667/668, seminar courses Biochemistry 745/746 and 790S, and 681 (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.

Courses in Biochemistry (BIOCHEM)

536. Bioorganic Chemistry. 4 units. C-L: see Chemistry 536

593. 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.

600. 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: Brennan, Briggs, Carbery, Cohn, and McIntosh. 4 units.
622. 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 622, Computational Biology and Bioinformatics 622

658. 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 658, Cell Biology 658, University Program in Genetics 658, Immunology 658, Structural Biology and Biophysics 658, Computational Biology and Bioinformatics 658

659. Structural Biochemistry II. Continuation of Biochemistry 658. Structure/function analysis of proteins as enzymes, multiple ligand binding, protein folding and stability, allostery, protein-protein interactions. Prerequisites: Biochemistry 658, organic chemistry, physical chemistry, and introductory biochemistry. Instructors: Zhou and staff. 2 units. C-L: Cell Biology 659, Immunology 659, Computational Biology and Bioinformatics 659, Structural Biology and Biophysics 659, University Program in Genetics 659


668. 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: Been and Staff. 2 units. C-L: Cell Biology 668, Immunology 668, University Program in Genetics 668

681. Physical Biochemistry. A structure-based introduction to the role of thermodynamic driving forces in biology. An overview of experimental sources of structural and dynamic data, and a review of the fundamental concepts of thermodynamics. Both concepts are combined to achieve a structural and quantitative mechanistic understanding of allosteric regulation, and of coupled ligand binding and conformational change. Statistical thermodynamics is used to develop ensemble models of protein and nucleic acid dynamics. This treatment leads into specific examples and general principles of how to interpret structural and dynamic information toward the purposes of other research. Instructor consent required. Instructor: Oas. 3 units. C-L: Structural Biology and Biophysics 681

695. Macromolecular Structure Determination by NMR Spectroscopy and X-ray Crystallography. Theoretical and experimental principles of nuclear magnetic resonance (NMR) spectroscopy and macromolecular x-ray crystallography. Topics of NMR cover theory, data collection and interpretation of macromolecular NMR experiments, including 1D, 2D, and multidimensional NMR data collection and interpretation, chemical exchange, protein dynamics, residual dipolar couplings, and solution structure determination. Emphasis on crystal symmetry, space group determination, diffraction theory, and a practical understanding of macromolecular crystallization, x-ray intensity data collection, macromolecular structure determination, refinement, and analysis. Prerequisites: Undergraduate physical chemistry, undergraduate biochemistry, and one year of calculus. Instructor consent required. Instructor: Schumacher. 4 units.

745S. Biochemistry Seminar. Required of all second- and third-year biochemistry students. Credit/no credit grading only. Instructor: Brennan. 1 unit.

746S. Biochemistry Seminar. Required of all second- and third-year biochemistry students. Credit/no credit grading only. Instructor: Brennan. 1 unit.

760. Cellular Signaling. 3 units. C-L: see Cell Biology 760; also C-L: Molecular Cancer Biology 760, Pharmacology and Cancer Biology 760

790S. Seminar (Topics). Topics and instructors announced each semester. 2 units or variable. Instructor: Kuehn. Variable credit.
Science & Society is a campus-wide initiative at Duke founded in 2013 to promote interdisciplinary education and scholarship that examine the integral role of science in law, policy, social institutions, and culture. Science & Society offers a Master of Arts in Bioethics and Science Policy, a program that teaches students how to identify, analyze, and propose solutions to address cutting edge and historical developments in science, medicine, technology and policy. The program provides a foundation in the history, philosophy, legal, social, and theoretical approaches to bioethical analysis, as well as an introduction to science and health policy. A distinguishing feature of the program is the option for students to select a topical area in which to concentrate their advanced studies. These concentrations represent existing or emerging areas of knowledge that pose complex questions about the relationship between science, ethics, and society. The three pre-designed concentrations are Genomics, Neuroscience, and Public Impact and Engagement. Students may also design an independent concentration with program faculty.

Degree Requirements

The MA in Bioethics and Science Policy requires a minimum of 36 credits, and can be earned in one year on a full-time basis (3 full semesters) or up to 3 years (6 semesters) on a part-time basis.

Requirements include:

- 5 required core classes (15 credits)
- 4 elective classes, one of which must be a biostatistics or methodology course (12 credits): Students may select electives from an extensive list of options from across the University or may choose to concentrate by choosing electives from one of several “tracks.”
- 1 Capstone Project (9 credits): Each student will complete a capstone project under the guidance of a faculty mentor, either an in-depth research paper, or a field placement (“practicum”), with a written report analyzing the experience and integrating concepts learned in the program. The capstone project is designed to demonstrate that a student has acquired extensive knowledge of current thinking in bioethics; has collected, synthesized, and reflected on these issues; and has developed competence in scholarly writing.

Situated within the Science & Society initiative at Duke, the Master of Arts in Bioethics and Science Policy and the broader initiative offer a host of workshops and programs to deepen student understanding of the field, help students consider career options, and connect students with leaders in bioethics and science policy and with other departments on campus.

Courses in Bioethics and Science Policy (BIOETHIC)

601S. Foundations of Bioethics & Science Policy. An introduction to the philosophical foundations of bioethics and bioethical policy, including (1) major ethical theories [consequentialism, deontology], (2) important philosophical analyses of key ethical concepts, [e.g. well-being, autonomy, rights, respect for persons, consent, coercion, exploitation, fairness], and (3) the practices of rigorous argumentation. The aim is to give students a more sophisticated understanding of the values at play in major ethical disputes, while enabling students to engage productively with these debates by improving their ability to argue, and their ability to express themselves with clarity and precision. Consent of instructor required for undergraduates. Instructor: Hawkins. 3 units.

602S. Law, Research and Bioethics. An examination of the relationship between the law and bioethical issues, particularly in research and medical contexts. The course will explore the ways scientific advances affect law and other social institutions, and, conversely, how law affects the development and use of scientific knowledge. Topics include the history of human subject protections, current regulatory and statutory issues in research, and legal decisions governing informed consent, confidentiality, privacy, and other issues. Consent of instructor is required for undergraduates. Instructor: Dame. 3 units.

603S. Clinical Bioethics and Policy. An examination of the leading issues in bioethics, especially those that arise in the context of clinical decision-making and the doctor-patient encounter. The focus will be on the ethical dilemmas faced by medical providers, patients, and their families: how issues are analyzed, what values are considered, and how disputes are resolved. Topics will include end-of-life care; withdrawal or refusal of life-sustaining treatment; pediatric ethics; transplantation; and rationing of scarce drugs or resources. The course will use real case examples to illustrate these dilemmas and challenges. Consent of instructor is required for undergraduates. Instructor: Rosoff. 3 units.
605S. Contemporary Issues in Bioethics and Science Policy. An introduction to cutting-edge developments in science, medicine, and technology as well as the difficult ethical questions they raise. This two-semester course will meet every other week and will feature guest speakers, including policy-makers, regulators, criminal investigators, legislators, activists, and prominent academics in the fields of policy, bioethics, law, and neuroscience. Students will have the opportunity to engage with speakers and to explore potential career paths. Consent of instructor is required for undergraduates. Instructor: Katsanis. 1.5 units.

606S. Activism and Advocacy Among Patients and Research Participants. In the 1960s, patients appropriated the language and tactics of the civil rights movement to advance clinical and research agendas. In today's post-genomic and digital information era, patient activism is evolving, leading to new solutions, dilemmas, and organizational structures. This course will examine patient and research participant activism and the ways it challenges conventional notions of expertise, amateurism, "human subjects protections," and minimization of risk. Students will bring the tools of investigative journalism, humanities scholarship, and community engagement/citizen science to bear on ethical and policy questions. Instructor consent required for undergraduates. Instructor: Angrist. 3 units.

607. Introduction to Genetics and Genomics. An introduction to the fields of genetics and genomics for students without a formal science background. The course begins with an overview of the structure and function of DNA and the genome, and an introduction to the lab techniques and technologies used in these fields. Students will learn how scientists sequence a genome and how they "map" a disease gene. The course will conclude with an examination of the health and societal applications of genetics and genomics. Throughout the course, examples of ethical controversies will be provided to give perspective to the science. Consent of instructor is required for undergraduates. Instructor: Minear. 3 units.

700. Research Independent Study in Bioethics and Science Policy. Individual research in a bioethics and science policy topic of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing analysis and interpretation of a previously approved topic. Requires consent of supervising instructor and Director of Graduate Studies. Instructor: Staff. Variable credit.

704. Science Law and Policy. What are the government policies that support science? What can science contribute to law and policy? How do different agencies govern the progress of scientific discovery? How do disparate regulations impact scientific funding in controversial areas like stem cell research? How is scientific research funded? What are the rules regarding research involving individuals, or the role of academic science in national innovation? These questions and more will be explored by reviewing the history of US science policy since World War II, and looking at the interaction of law, science, and policy with an emphasis on the life sciences in the United States. Instructor: Farahany. 3 units.

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.

Biological and Biologically Inspired Materials 85
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/.

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

Biology
Professor Noor, Chair (143 Biological Sciences Building); Professor Pryer, Director of Graduate Studies (139B Biological Sciences Building); Professors Alberts, Barber, Benfey, Brandon, Clark, Cunningham, Dong, Donohue, Forward, Goldstein, Hartemink, Jackson, Johnsen, Kiehart, Manos, McClay, McShea, Mitchell-Olds, Morris, F. Nijhout, Noor, Nowicki, Pryer, Rausher, Reynolds, Rodrigo, Rosenberg, Shaw, Siewow, Smith, Staddon, Sun, Terborgh, Uyenoyama, Vilgalys, Willard, Willis, Wray, and Yoder; Associate Professors Bejsovec, Bernhardt, Drea, Haase, Koelle, Lutzoni, Magwene, Pei, Rittschof, Roth, D. Sherwood, and Wilson; Assistant Professors Baugh, Bhandawat, Buchler, Chen, Schmid, Volkan, Wright; Professors Emeriti Boynton, Fluke, Gillham, Klopfer, Nicklas, Searles, Strain, Tucker, Wainwright, White, and Wilbur; Research Professors Cook-Deegan, Christensen, Livingstone and Vogel

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; 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 Pratt School of Engineering (biomechanics); the Medical Center (molecular biology and genomics); and the Nicholas School of the Environment (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: The 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 Pratt School of Engineering and the Nicholas School of the Environments.

Courses in Biology (BIOLOGY)
515. Principles of Immunology. 3 units. C-L: see Immunology 544


517S. From Neurons to Development: The Role of Epigenetics in Plasticity. Readings and discussion of current literature on epigenetics and plasticity. A comparative look at epigenetic factors in mediating plasticity in biological
systems from neuronal learning to development and aging. Prerequisites: Biology 201L and Psychology 106. Instructor: Volkan. 3 units. C-L: Neuroscience 517S

540L. Mycology. Survey of the major groups of fungi with emphasis on life history and systematics. Field and laboratory exercises. Instructor: Vilgalys. 3 units.

546S. Biology of Mammals. The biology of mammals: diversity, evolutionary history, morphology, and aspects of physiology and ecology. Local field trips. Prerequisite: Biology 20 or 202L or equivalent. Instructor: Roth. 3 units.

547L. Entomology. The biology of insects: diversity, development, physiology, and ecology. Field trips. Prerequisite: Biology 20 or 202L or equivalent. Instructor: H. Nijhout. 4 units.

548L. Herpetology. Biology of recent amphibians and non-avian reptiles, evolutionary history, morphology, life history, physiology, behavior, and ecology. Local field trips. Prerequisites: Biology 20 or equivalent. Instructor: Staff. 4 units.

554. 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 201L and 202L or equivalent course. Instructor: Wray. 3 units. C-L: Evolutionary Anthropology 514

555S. Problems in the Philosophy of Biology. 3 units. C-L: see Philosophy 634S

556. Systematic Biology. Theory and practice of identification, species discovery, phylogeny reconstruction, classification, and nomenclature. Prerequisite: Biology 202L or equivalent. Instructor: Lutzoni. 3 units.

556L. Systematic Biology. Laboratory version of Biology 556. Theory and practice of identification, species discovery, phylogeny reconstruction, classification, and nomenclature. Prerequisite: Biology 202L or equivalent. Instructors: Lutzoni and Swofford. 4 units.

557L. 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 20 or 212L or 201L or 202L. Instructor: Vilgalys. 4 units.

559S. 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.

560. 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: Recommended: One course in ecology. Instructor: Jackson. 3 units.

561. Tropical Ecology. 3 units. C-L: see Environment 517

563S. Stormwater Science: Pollution, Pavement, and Precipitation. Examines pollution emissions/deposition, impervious surfaces, evapotranspiration, groundwater, stormwater runoff, nutrients, thermal pollution, and freshwater effects. Uses primary literature, as well as a couple of books. Also examines "stormwater control measures" that mitigate problems. Student-driven course: Reading, presenting, and discussing primary literature, asking/answering questions in class, and seeking answers. Course designed for graduate and advanced undergraduate students. Prerequisites: one course in Ecology or Environmental Science or instructor consent. Instructor: Wilson. 3 units. C-L: Environment 565S

564. 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 101DL or equivalent; Recommended: Chemistry 210DL. Instructor: Bernhardt. 3 units. C-L: Environment 564

565L. 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 575L

567S. 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.

570LA-1. 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.

570LA-2. 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 273LA and consent of instructor. Instructor: Staff. 2 units.

570LA-3. 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 Parc 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.

571A. Sojourn in Singapore: Urban Tropical Ecology. 3 units. C-L: see Environment 571A

579LA. Biological Oceanography. Variable credit. C-L: see Environment 579LA; also C-L: Earth and Ocean Sciences 579LA

588S. 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 202L or equivalent. Recommended: one course in plant or animal diversity and one course in evolution beyond 202L. Instructor: Roth. 3 units. C-L: Evolutionary Anthropology 588S

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

590S. Seminar (Topics). Seminar on a selected Topic. Offerings vary each semester. Instructor: Staff. 3 units.

605S. Modeling biological systems using Matlab. Introduction to Matlab programming and numerical methods for biological systems. Implementation of models for ecological and evolutionary dynamics and cellular and molecular dynamics. Topics covered include basic programming fundamentals (for/while/if statements), data input/output, data structures, numerical simulations of deterministic and stochastic systems. Includes a final project, decided upon by the student. Prerequisites: Bio 201L and 202L, or the equivalent, or consent of the instructor. Instructor: Koelle. 3 units.

627. Molecular Ecology. 3 units. C-L: see Environment 627; also C-L: Genome Sciences and Policy 627

650. 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.

651S. 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.
652S. 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.

665. Bayesian Inference for Environmental Models. Formulation of environmental models and applications to data using R. Distribution theory, algorithms, and implementation. Topics include physiology, population growth, species interactions, disturbance, and ecosystem dynamics. Discussions focus on classical and current primary literature. Instructor: J. Clark. 3 units. C-L: Environment 665

668. 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: One course in Ecology. Instructor: Morris. 3 units.


678. Population Ecology for a Changing Planet. 3 units. C-L: see Environment 678

701. 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. C-L: University Program in Genetics 711

702. 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. C-L: University Program in Genetics 712

705S. 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." Instructor: J. A. Reynolds. 1 unit.

711S. Ecology Seminar. Discussion of current research and literature. Instructor: Staff. 1 unit.

712S. Plant Systematics Seminar. Weekly presentation of current research in plant systematics by students, faculty, and invited speakers. Instructor: Vilgalys. 1 unit.

715S. 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.

717S. Plant Biology Forum. Modern contemporary research on the plant model species Arabidopsis thaliana. Prerequisites: Coursework in molecular and cell biology. Instructor: Chen. 1 unit.

718S. 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.

720. 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.

723. 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.

724L. 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 plant 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.

725. Microscopy and Image Analysis. Concepts and theory involved in a wide variety of microscopy and image analysis. The course is intended for people who will do a significant amount of biological imaging in their graduate research and is best taken after starting to do some imaging. Areas covered: Transmitted light, fluorescence, widefield imaging, scanning confocal, TIRF, live-cell imaging, multiphoton excitation, spinning disk, super-resolution microscopy, imaging techniques, image processing, visualization and analysis. FIJI/ImageJ is used with interactive exercises to complement theory involved in image processing and analysis. Consent of the instructor is required (numbers are limited). Instructor: Johnson. 1 unit.

726. Dynamic Modeling of Biological Systems. Covers a range of approaches used in the dynamic modeling of biological systems, with applications to ecology, evolution, cellular and molecular biology. Modeling approaches discussed include: difference equations, differential equations, and individual-based models. Analysis of models will include analytical approaches as well as approaches based on simulation. Simulation of models will use the software program Matlab. Instructor: Koelle. 3 units. C-L: Computational Biology and Bioinformatics 726

727. Image processing for bioscientists. Broad introduction to the principles behind image-based data. Aimed at graduate students actively working in research labs but assumes no prior experience with programming or any computational background beyond that of a typical PC/Mac user. Covers images generally but examples will be based on the types of images commonly used in biological research. Topics: Image fundamentals, Basic image processing, Image compression, Image storage and informatics, 3D and 4D data, Making accurate and optimal figures, Image integrity, Video, Quantification, Limits and confounds in analysis, automation of image processing and analysis. Lecture and computational exercises. 3 units. Instructor: Johnson. 3 units.

728. Genetic Approaches to the Solution of Biological Problems. 4 units. C-L: see University Program in Genetics 778; also C-L: Cell and Molecular Biology 778, Molec Genetics & Microbiology 778

729. Ecological Forecasting Workshop. As part of Duke University's new Center for Global Change, this course is a hands-on workshop in ecological data modeling and application to forecasting. Students will assemble in groups with complimentary expertise in ecology, statistics, and computation. Each group will develop a proposal for the semester long project. An example might be a modeling exercise on forecasting that involves prediction, uncertainty, and novel spatial algorithms. Proposals would provide motivation, set goals, and define instructional needs for their project. Faculty will review proposals, provide feedback, and then organize appropriate lectures, discussion sections, and tutorials. They will provide oversight as work progresses. Instructors: Agarwal, Clark, Lavine, Urban. 3 units.

730. Evolutionary Mechanisms. Population ecology and population genetics of plants and animals. Fitness concepts, life history evolution, mating systems, genetic divergence, and causes and maintenance of genetic diversity. Instructor: Rausher. 3 units.

772LA. Biochemistry of Marine Animals. Variable credit. C-L: see Environment 772LA

773. 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, beaches, 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 Biology 273LA and not open to undergraduates. (Given at Beaufort fall and summer). Prerequisite: Introductory Biology. Instructors: Silliman or staff. 4 units. C-L: Environment 773A

773LA. 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 Biology 273LA and not open to undergraduates. (Given at Beaufort.) Prerequisite: Introductory Biology. Instructors: Silliman or staff. 4 units. C-L: Environment 773LA
Biomolecular and Tissue Engineering

777LA. Marine Invertebrate Zoology. Variable credit. C-L: see Environment 788LA

778LA. Physiology of Marine Animals. Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Open to undergraduates only under Biology 278LA. Four units (fall); six units (summer). (Given at Beaufort.) Prerequisites: introductory biology and chemistry. Instructor: Forward. Variable credit. C-L: Environment 778LA

782. Mechanisms of Development/Developmental Genetics. 2 units. C-L: see Cell Biology 810

783. Developmental Genetics. 2 units. C-L: see Cell Biology 820

784LA. Sound in the Sea: Introduction to Marine Bioacoustics. 4 units. C-L: see Environment 784LA; also C-L: Electrical and Computer Engineering 784LA

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

790S. Special Topics Seminar. Seminar on a selected topic. Offerings vary each semester. Instructor: Staff. Variable credit.

791T. 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.

791TA. Tutorial. Carried out under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Taught only in the Beaufort Marine Lab program. Instructor: Staff. Variable credit.

792. 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.

792A. Research. To be carried out under the direction of the appropriate faculty members. Consent of instructor required. Hours and credit to be arranged. Taught only in the Beaufort Marine Lab program. Instructor: Staff. Variable credit.

803. 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 803

841. Ecological perspectives: Individuals to communities. 4 units. C-L: see University Program in Ecology 701; also C-L: Environment 841

842. Ecological perspectives: Ecophys to Ecosystems. 4 units. C-L: see University Program in Ecology 702; also C-L: Environment 842

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: an approved lab-based course in modern
biotechnology and seminars in biomolecular and tissue engineering; 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 Student)
- one lab-based class in modern biotechnology
- four semesters credit of biological engineering seminar series
- four BTE electives
- two nonengineering biomedical science classes.
- participation in BTE activities, such as the annual poster session and chalk talks

Requirements (Non-Engineering Student)
- one lab-based class in modern biotechnology
- four semesters of credit of biological engineering seminar series
- two BTE electives
- two nonengineering biomedical science classes
- participation in BTE activities, such as the annual poster session and chalk talks

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

Biostatistics
Associate Professor Gregory P. Samsa, Director of Graduate Studies; Assistant Professor Megan L. Neely, Assistant Director of Graduate Studies

As biomedical research becomes increasingly quantitative and complex, a need exists for individuals who possess exceptional analytic skills, a strong foundation in human biology, and the ability to effectively communicate statistical principles to multi-disciplinary research teams. Demand is particularly high for individuals formally trained in biostatistics.

Duke University Medical Center is a world-class medical research institution that provides the ideal setting for training biostatisticians to gain exposure to state-of-the-art biostatistical methodology in the context of cutting edge science research. Duke's PhD program in biostatistics is unique in its balanced focus on three core competencies: analysis, biology, and communication. All faculty members in the Department of Biostatistics and Bioinformatics at Duke are actively engaged in research, with projects collectively spanning a broad array of biomedical research areas. Faculty members actively practice what they teach and are dedicated to ensuring that students develop the skills and knowledge necessary to succeed as biostatisticians.

For more information about the PhD program in biostatistics, please visit our program website: http://biostat.duke.edu/phd-program. If you should have any additional questions, you may contact Jonathan Hecht at: jonathan.hecht@duke.edu.

Courses in Biostatistics (BIOSTAT)
701. Introduction to Statistical Theory and Methods I. This course provides a formal introduction to the basic theory and methods of probability and statistics. It covers topics in probability theory with an emphasis on those needed in statistics, including probability and sample spaces, independence, conditional probability, random variables, parametric families of distributions, sampling distributions. Core concepts are mastered through mathematical exploration, simulations, and linkage with the applied concepts studied in BIOSTAT 704. Prerequisite: 2 semesters of calculus or its equivalent (multivariate calculus preferred). Familiarity with matrix algebra is helpful. Corequisites: Biostatistics 702, Biostatistics 703 Credit: 3. 3 units.

702. Applied Biostatistical Methods I. This course provides an introduction to study design, descriptive statistics, and analysis of statistical models with one or two predictor variables. Topics include principles of study design, basic study designs, descriptive statistics, sampling, contingency tables, one- and two-way analysis of variance, simple linear regression, and analysis of covariance. Both parametric and non-parametric techniques are explored. Core concepts are mastered through team-based case studies and analysis of authentic research problems encountered by program faculty and demonstrated in practicum experiences in concert with BIOSTAT 703. Computational exercises will use the R and SAS packages. Prerequisite: 2 semesters of calculus or its equivalent (multivariate calculus preferred). Familiarity with matrix algebra is helpful. Corequisites: Biostatistics 701, Biostatistics 703, Biostatistics 721 Credit: 3. 3 units.
703. Introduction to the Practice of Biostatistics I. This course provides an introduction to biology at a level suitable for practicing biostatisticians and directed practice in techniques of statistical collaboration and communication. With an emphasis on the connection between biomedical content and statistical approach, this course helps unify the statistical concepts and applications learned in BIOSTAT 701 and BIOSTAT 702. In addition to didactic sessions on biomedical issues, students are introduced to different areas of biostatistical practice at Duke University Medical Center. Biomedical topics are organized around the fundamental mechanisms of disease from both evolutionary and mechanistic perspectives, illustrated using examples from infectious disease, cancer and chronic/degenerative disease. In addition, students learn how to read and interpret research and clinical trial papers. Core concepts and skills are mastered through individual reading and class discussion of selected biomedical papers, team-based case studies and practical sessions introducing the art of collaborative statistics. Corequisites: Biostatistics 701, Biostatistics 702 Credit: 3.3 units.

704. Introduction to Statistical Theory and Methods II. This course provides formal introduction to the basic theory and methods of probability and statistics. It covers topics in statistical inference, including classical and Bayesian methods, and statistical models for discrete, continuous and categorical outcomes. Core concepts are mastered through mathematical exploration, simulations, and linkage with the applied concepts studied in Biostatistics 705. Prerequisite: Biostatistics 701 or its equivalent. Corequisites: Biostatistics 705, Biostatistics 706 Credit: 3.3 units.

705. Applied Biostatistical Methods II. This course provides an introduction to general linear models and the concept of experimental designs. Topics include linear regression models, analysis of variance, mixed-effects models, generalized linear models (GLM) including binary, multinomial responses and log-linear models, basic models for survival analysis and regression models for censored survival data, and model assessment, validation and prediction. Core concepts are mastered through statistical methods application and analysis of practical research problems encountered by program faculty and demonstrated in practicum experiences in concert with BIOSTAT 706. Computational examples and exercises will use the SAS and R packages. Prerequisite(s): BIOSTAT 702 or its equivalent; linear and matrix algebra Corequisite(s): Biostatistics 704, Biostatistics 706, Biostatistics 722 Credits: 3.3 units.

706. Introduction to the Practice of Biostatistics II. This course revisits the topics covered in BIOSTAT 703 in the context of high-throughput, high-dimensional studies such as genomics and transcriptomics. The course will be based on reading of both the textbook and research papers. Students will learn the biology and technology underlying the generation of "big data", and the computational and statistical challenges associated with the analysis of such data sets. As with BIOSTAT 703, there will be strong emphasis on the development of communication skills via written and oral presentations. Prerequisite: Biostatistics 703 Corequisites: Biostatistics 704, Biostatistics 705 Credit: 3.3 units.

707. Statistical Methods for Learning and Discovery. This course surveys a number of techniques for high dimensional data analysis useful for data mining, machine learning and genomic applications, among others. Topics include principal and independent component analysis, multidimensional scaling, tree based classifiers, clustering techniques, support vector machines and networks, and techniques for model validation. Core concepts are mastered through the analysis and interpretation of several actual high dimensional genomics datasets. Prerequisites: Biostatistics 701 through Biostatistics 706, or their equivalents. Credit: 3.3 units.

708. Clinical Trial Design and Analysis. Topics include early phase through late phase clinical trials, including two-stage, Simon's optimal design, parallel group, crossover, cluster randomized, and adaptive designs. Objectives such as endpoint selection, dose range, maximum tolerated dose, non-inferiority, surrogate outcomes, and safety will be considered. Methods for group sequential testing, will include fixed group sequential, O'Brien-Fleming, Pocock, one-sided, Tsiatis, Whitehead triangular and other tests. Test cases may include confidence intervals, and a range of related topics in monitoring trials. Prerequisites: Biostatistics 701, Biostatistics 704, or permission of the Director of Graduate Studies Credits: 2.2 units.

709. Observational Studies. Methods for causal inference, including confounding and selection bias in observational or quasi-experimental research designs, propensity score methodology, instrumental variables and methods for non-compliance in randomized clinical trials. Prerequisites: Biostatistics 701, Biostatistics 702, or permission of the Director of Graduate Studies Credits: 2.2 units.

710. Statistical Genetics and Genetics Epidemiology. Topics from current and classical methods for assessing familiality and heritability, linkage analysis of Mendelian and complex traits, family-based and population-based
association studies, genetic heterogeneity, epistasis, and gene-environmental interactions. Computational methods and applications in current research areas. The course will include a simple overview of genetic data, terminology, and essential population genetic results. Topics will include sampling designs in human genetics, gene frequency estimation, segregation analysis, linkage analysis, tests of association, and detection of errors in genetic data. Prerequisites: Biostatistics 701, Biostatistics 704, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

712. Clustered Data Designs and Applications. Data collected within clusters are not generally independent and analysis strategies are needed to accommodate this construct. Focus will be on identifying clustered design structures, such as: patients within clinics and measurements over time on the same patient. The course will include design, sample size, and power implications for clustered studies and mechanisms for the analysis and estimation of the factors of interest, including the ICC components. Prerequisites: Biostatistics 201, Biostatistics 202, Biostatistics 204, Biostatistics 205, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

713. Survival Analysis. Introduction to concepts and techniques used in the analysis of time to event data, including censoring, hazard rates, estimation of survival curves, regression techniques, applications to clinical trials. Interval censoring, informative censoring, competing risks, multiple events and multiple endpoints, time dependent covariates; nonparametric and semi-parametric methods. Prerequisites: Biostatistics 701, Biostatistics 704, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

714. Categorical Data Analysis. Topics in categorical modeling and data analysis/contingency tables; measures of association and testing; logistic regression; log-linear models; computational methods including iterative proportional fitting; models for sparse data; Poisson regression; models for ordinal categorical data and longitudinal analysis. Prerequisites: Biostatistics 701, Biostatistics 702, Biostatistics 704, Biostatistics 705, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

715. Methods in Non-Parametric Statistics. An introduction to the theory and application of classical non-parametric methods with emphasis on applications to design and analysis of clinical and molecular studies: Classical rank tests; permutation resampling based inference; estimation of statistical functionals; functional Central Limit Theorem; influence functions; empirical distribution function; the jackknife and bootstrap; bias-variance tradeoff; curse of dimensionality; kernel smoothing and spline methods for density and regression estimation; isotonic regression; classical inequalities. Prerequisites: Biostatistics 201, Biostatistics 204, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

716. Integration of Biomarkers from Molecular and Cell Assays in Clinical Biostatistics. Statistical and computational issues associated with identification and clinical characterization of biomarkers, and integration of molecular and cell assays, including RNA and protein probe expressions, SNPs, copy-number variants, flow-cytometry data and other forms of emerging molecular markers in prognostic and diagnostic models: pre-processing of molecular assays including methods for background correction and normalization within and across experiments; methods for accounting for left and interval truncation in the probe intensities and cell counts; methods for identifying and addressing batch effects; methods for assessing agreement and consistency among assays; methods for assessing sensitivity and specificity of assays; data management and compression methods for high-dimensional data. Prerequisites: Biostatistics 201, Biostatistics 204, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

717. Stochastic Processes. An introduction to classical stochastic processes with an emphasis on applications in population genetics, molecular and cell biology and evolutionary biology: Random walks; Conditional probability and expectation; discrete Markov chains, branching trees; phylogenetic tree, counting process, Poisson process; renewal process; discrete martingales; Brownian motion; Simulation methods. Prerequisites: Biostatistics 201, Biostatistics 204, or permission of the Director of Graduate Studies. Credits: 2. 2 units.

718. Analysis of Correlated and Longitudinal Data. Topics include linear and nonlinear mixed models; generalized estimating equations; subject specific versus population average interpretation; and hierarchical models. Prerequisites: Biostatistics 701, 702, 704 and 705 or permission of the Director of Graduate Studies. Credit: 2. 2 units.

719. Generalized Linear Models. This class introduces the concept of exponential family of distributions and link function, and their use in generalizing the standard linear regression to accommodate various outcome types. Theoretical framework will be presented but detailed practical analyses will be performed as well, including logistic regression with Poisson regression and extensions. Majority of the course will deal with the independent observations framework. However, there will be substantial discussion of longitudinal/clustered data where correlations within
clusters are expected. To deal with such data the Generalized Estimating Equations and Generalized Linear Mixed models will be introduced. An introduction to the Bayesian analysis approach will be presented, time permitting. Prequisites: Biostatistics 701, 702, 704 and 705 or Permission of Director of Graduate Studies. Credit: 2.2 units.

720. Master's Project. Completed during a student's final year of study, the master's project is performed under the direction of a faculty mentor and is intended to demonstrate general mastery of biostatistical practice. Prequisites: BIOSTAT 701, 702, 703, 704, 705 and 706. Corequisite: Biostatistics 707. Credit: 6.3 units.

721. Introduction to Statistical Programming I (R). This course is an introduction to programming in R, targeted at statistics majors with minimal programming knowledge, which will give them the skills to grasp how statistical software works, tweak it to suit their needs, recombine existing pieces of code, and when needed create their own programs. Students will learn the core of ideas of programming (functions, objects, data structures, input and output, debugging, and logical design) through writing code to assist in numerical and graphical statistical analyses. Students will learn how to write maintainable code, and to test code for correctness. They will then learn how to set up stochastic simulations and how to work with and filter large data sets. Since code is also an important form of communication among scientists, students will learn how to comment and organize code to achieve reproducibility. Programming techniques and their application will be closely connected with the methods and examples presented in the co-requisite course. The primary programming package used in this course will be R. Co-requisite: Biostatistics 702. Credit: 2.2 units.

722. Introduction to Statistical Programming II (SAS). This course is an introduction to programming in SAS, targeted at statistics majors with minimal programming knowledge, which will give them the skills to grasp how statistical software works, tweak it to suit their needs, recombine existing pieces of code, and when needed create their own programs. Students will learn the core of ideas of programming (data step, procedures, ODS, input and output, debugging, and logical design) through writing code to assist in numerical and graphical statistical analyses. Students will learn how to write maintainable code, and to test code for correctness. They will then learn how to set up stochastic simulations and how to work with and filter large data sets. Since code is also an important form of communication among scientists, students will learn how to comment and organize code to achieve reproducibility. Programming techniques and their application will be closely connected with the methods and examples presented in the co-requisite course. The primary programming package used in this course will be SAS. Co-requisite: Biostatistics 705. Credit: 2.2 units.

801. Biostatistics Career Preparation and Development I. Prerequisite: Biostatistics 701, 702 and 703 Co-requisite: BIOSTAT 704, 705 and 706. 0.5 units.

802. Biostatistics Career Preparation and Development I. Prerequisite: Biostatistics 701 - 706 Co-requisite: BIOSTAT 707. 0.5 units.

Business Administration

Professor Boulding, 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, Brandt, Brav, Breeden, Chartrand, Q. Chen, W. Cohen, Coleman, Desai, Fischer, G. J. Fitzsimons, Francis, Gervais, Graham, Harvey, Hsieh, Huber, Larrick, Lewin, Lewis, Lind, Lopomo, Luce, Marx, McAdams, Mela, Moorman, Nau, Payne, Puri, Purohit, Rampini, Robinson, Schipper, Sheppard, Sitkin, J. Smith, Song, Staelin, Ubel, Venkatachalam, Viswanathan, and Winkler; Associate Professors Belenzon, Belloni, Britton, Brown, Chatterji, L. Chen, Cummings, Daley, Dyreng, G. M. Fitzsimons, Kay, Linville, Mayew, Olsson, Pekac, Rosette, Schmid, Shang, Soll, Sun, Swinney, and Wade-Benzioni; Assistant Professors Adelino, Arlotto, Balseiro, Canhongan, Ecker, Etkin, Jiang, Joseph, Kulchina, McDevitt, Varas, Vashishtha, Wei, and Yang; Professors Emeriti A. Ashton, Bradley, Burton, Clemen, Keller, Laughhun, McCann, Moore, and Zipkin; Research Professor Emeritus 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. Additional information may be obtained by visiting http://www.fuqua.duke.edu/.

Courses in Business Administration (BA)

901. 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 rationalizationibility. 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.

910. 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 502


912. 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.

913. 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 503

921. 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 includes presentation of behavioral research by members of The Fuqua School of Business and other researchers. Instructor: Staff. 3 units.

922. 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.

925. 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 716

931. 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.

932. 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 931 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.

933. 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.

951. Introduction to Finance. This course introduces students to a wide range of research topics in empirical corporate finance. Topics covered are related to capital structure, compensation, corporate tax effects, entrepreneurship, financial intermediation, governance, mergers and acquisitions, payout, and venture capital (though, not every topic is covered every year). The course is intended for Ph.D. students. Masters or other students must have 1) already taken Finance I and received an "A", and 2) request instructor permission to take this course. Instructor: Staff. 3 units.

952. 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.

953. 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.

954. 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.

961. Seminar in Quantitative Research in Marketing. Research in marketing endeavors to explain consumer and firm behaviors and use these to inform 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.

962. 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 715
963. 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.

964. 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.

965. Automaticity. In this class, we explore the explosion of research in automaticity and nonconscious processes over the past 35 years, which was facilitated by the development of new cognitive and social-cognitive methodologies. During that time, automaticity has been applied to classical social psychological phenomena, including judgments, attitudes, emotion, motivation, and behavior. We will review some representative examples of the wide range of theoretical and empirical work on automaticity. Our analysis will be closely linked with issues such as unconscious vs. conscious processing, attention, control, intentionality, and free will. Instructor: Chartrand. 3 units. C-L: Psychology 772

966. Social Cognition. This course is intended to provide an introduction to research in social cognition. Social cognition is the study of the cognitive underpinnings of social behavior. The focus is on better understanding how we think about ourselves and our social world. Specifically, researchers examine how we select, interpret, remember, and use social information to make judgments and decisions, and the downstream consequences of this process for affect, motivation, cognition, and behavior. Instructor: Chartrand. 3 units. C-L: Psychology 771

991. 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.

996. 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.

997. 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.

998. 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.

999. 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
Professor Jane Moss, Director

A certificate is available in this program.

Founded in 1974, the Duke Center for Canadian Studies is the oldest in the United States. The program coordinates research, teaching, and outreach about Canada within the context of North America and the world, and sponsors speakers and seminars. The center also offers a graduate certificate, open to all advanced degree students who meet the necessary requirements, and who wish to formalize and expand their knowledge of Canada.

To receive the graduate certificate in Canadian studies, the following criteria must be met:
• completion of three, graduate-level courses in Canadian studies, including the core course, Canadian 282S, an interdisciplinary course, or an equivalent independent study;
• demonstrate two years of college-level French proficiency, a native North American language, or a “heritage language” used in Canada, or equivalent knowledge, as certified by the Department of Romance Languages; and
• completion of a graduate thesis, dissertation, or final project on a Canadian or Canadian-comparative topic.
The program also offers a limited number of foreign language, research, and conference travel scholarships. The director of the center, as well as the dean of the graduate center, will sign the certificate and appropriate notation will be made on the student’s transcript. For any questions, please contact the Center for Canadian Studies at the John Hope Franklin Center, 2204 Erwin Road, Box 90422, Durham, NC 27708; (919) 681-3262; http://www.jhfc.duke.edu/canadianstudies/.

Cell Biology
Professor Hogan, Chair; Associate Professor Lechler, Director of Graduate Studies; Professors Capel, Caron, Endow, Erickson, Katsanos, McIntosh, Nicchitta, Poss, and Reedy; Associate Professors Corless, Klingensmith, Soderling, Vigna; Assistant Professors Bagnat, Eroglu, Di Talia, Kuo; Associate Research Professors Barak, Jakoi, Le Furgey; Assistant Research Professors Carbery, Perez-Edwards

The Department of Cell Biology offers graduate training in cell and molecular biology, developmental biology, and physiology. Molecular cell biology research interests include molecular mechanisms of signal transduction, the cytoskeleton, motor proteins, cell motility, cell polarity, mechanisms of muscle contraction, membrane biophysics, tissue morphogenesis, tissue regeneration, mRNA localization, synapse formation, neural circuitry, stem cell biology, and the genetic/cellular basis of disease. A number of cell biology faculty address cell biology in the context of developing organisms such as mouse, zebrafish, and fly. Developmental interests include germ and stem cells and stem cells, neuronal 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 addiction and innate immunity, as well as heart, lung, gut, muscle, and reproductive organ function. 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, and mouse genetics.

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.

Courses in Cell Biology (CELLBIO)

503. 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: Carbery and Jakoi. 3 units.

551. Cell and Molecular Biology. 4 units. C-L: see Cell and Molecular Biology 551

658. Structural Biochemistry I. 2 units. C-L: see Biochemistry 658; also C-L: Cell and Molecular Biology 658, University Program in Genetics 658, Immunology 658, Structural Biology and Biophysics 658, Computational Biology and Bioinformatics 658

659. Structural Biochemistry II. 2 units. C-L: see Biochemistry 659; also C-L: Immunology 659, Computational Biology and Bioinformatics 659, Structural Biology and Biophysics 659, University Program in Genetics 659

668. Biochemical Genetics II: From RNA to Protein. 2 units. C-L: see Biochemistry 668; also C-L: Immunology 668, University Program in Genetics 668

680. Molecular Cardiovascular Biology. 2 units. C-L: Pharmacology and Cancer Biology 680

701. Human Structure and 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.

720. 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.
730. 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, Kuo, and Poss. 3 units. C-L: Molecular Cancer Biology 730, Pharmacology and Cancer Biology 730

760. 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, and invited lecturers. 3 units. C-L: Biochemistry 760, Molecular Cancer Biology 760, Pharmacology and Cancer Biology 760

800S. 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.

810. 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 783. 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 782. Instructors: Klingensmith and McClay. 2 units. C-L: Biology 782

820. 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 Drosophilia, C. elegans, mouse and zebrafish, where genomics, mutations, gene modifiers, epistasis analysis, 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: Klingensmith and McClay. 2 units. C-L: Biology 783

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

850. 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.

Cell and Molecular Biology
Daniel Lew, Director (Department of Pharmacology and Cancer Biology); Meta Kuehn, Director of Graduate Studies (Department of Biochemistry); 146 participating faculty

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 eleven departments/programs at Duke University: biochemistry, biology, cell biology, computational biology and bioinformatics, genetics and genomics, immunology, molecular cancer biology, 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 146 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 curriculum totals 24 course credits and includes the following two core courses as well as courses recommended or required by the PhD-granting department:
  - Cell and Molecular Biology 551 for two semesters
  - Cell and Molecular Biology 764 for four semesters

For additional information, please visit [http://cmb.duke.edu](http://cmb.duke.edu).

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

551. **Cell and Molecular Biology.** This class covers a wealth of cell and molecular biology in a modular format, with modules focusing on either critical discussion of primary literature, developing quantitative/mathematical approaches to the biology, or both. Each module consists of five or six classes. Students select six (non-concurrent) modules; each module contributes to 10% of the final grade. At the end of the class, students develop a research proposal with an assigned faculty coach. All proposals are presented to the class in a 2-day symposium, contributing 40% of the final grade. Undergraduates require permission of coordinator to enroll. Instructors: Lew and Nicchitta. 4 units. C-L: Cell Biology 551

658. **Structural Biochemistry I.** 2 units. C-L: see Biochemistry 658; also C-L: Cell Biology 658, University Program in Genetics 658, Immunology 658, Structural Biology and Biophysics 658, Computational Biology and Bioinformatics 658

733. **Experimental Design and Biostatistics for Basic Biomedical Scientists.** 2 units. C-L: see Pharmacology and Cancer Biology 733; also C-L: Neurobiology 733, Biomedical Engineering 733

764. **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.

778. **Genetic Approaches to the Solution of Biological Problems.** 4 units. C-L: see University Program in Genetics 778; also C-L: Molec Genetics & Microbiology 778, Biology 728

797. **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.

**Chemistry**

Professor Craig, Chair (3221 French Family Science Center); Professor Hong, Director of Graduate Studies (1101 FFSC); Professors Al-Hashimi, Baldwin, Beratan, Chilkoti, Craig, Crumbliss, Curtarolo, Donald, Fitzgerald, Lefkowitz, Liu, McCafferty, Oas, Reichert, Therien, Toone, Vo-dinh, Warren, West, Widenhoefer, Yang, Zauscher; Associate Professors, Ferguson, Franz, Hong, MacPhail, Zhou; Assistant Professors Charbonneau, Derbyshire, Hargrove, Lu, Malcomson, Roizen, Wang, Wiley, Yokoyama; Professors Emeriti Arnett, Chesnut, Lochmuller, MacPhail, Palmer, Quin, Shaw, 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, physical, and theoretical chemistry, and there are active research programs in each of these areas.
In addition, chemistry graduate students are also involved in a variety of interdisciplinary research programs, including biological chemistry, toxicology, pharmacology, and molecular biophysics.

Students should complete 22 course credits by the end of the fall semester of the second year of residence. Normally, students will complete a minimum of 12 course credits during their first semester, along with the research orientation seminar (Chemistry 701S). 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: dgs@chem.duke.edu, or our website at http://www.chem.duke.edu/.

Courses in Chemistry (CHEM)


506. 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 501 or consent of instructor. Instructor: Fitzgerald. 2 units.

511. Chemistry of Biomolecular Interactions. Chemistry of the noncovalent interactions governing biological systems. Topics include: review of biomacromolecules; chemical principles of non-covalent interactions and the use of model systems; experimental methods to determine binding interactions; interactions responsible for molecular recognition in biological systems; and applications in signal regulation. Recommended precursor to Chemistry 518. Instructor: Hargrove. 4 units.

518. Chemical Biology. 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, and Wang. 4 units.

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

524. 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.


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

532. Organic Reactions. Highlights strategic operations that enable selective synthesis of small molecules, including organic ligands, natural products, and molecular probes. Topics include chemical synthesis and retrosynthetic analysis; arrow-pushing mechanisms of polar, radical, transition metal-mediated and pericyclic reactions; protecting groups, oxidation, reduction, enolate reactivity; stereoselective reactions and conformational analysis; cross-coupling transformations. Instructor: Roizen. 4 units.


535. Organic Synthesis. Application of organic reactions to the synthesis of structurally and biologically interesting compounds. Topics include synthetic design, retrosynthetic analysis, synthetic methods, and total syntheses of natural products. Prerequisite: Chemistry 532 or consent of instructor. Instructor: Hong. 4 units.
536. **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. Instructors: McCafferty and Toone. 4 units. C-L: Biochemistry 536

538. **Organometallic Chemistry and Catalysis.** Introduction to the structure and bonding of organometallic and coordination complexes, stressing the origin of metal-ligand interactions from a molecular orbital theory perspective. Elementary reactions of transition metal complexes and their application to organic synthesis, with special emphasis on catalytic reactions. General concepts of catalysis and the advantages and benefits of catalytic systems. Instructor: Malcolmson. 4 units.

541. **Quantum Chemistry.** Foundations and approximate methods in quantum chemistry, with an emphasis on their applications to molecular structure and modeling. Instructors: Beratan, Liu, MacPhail, Warren, and Yang. 4 units.

542. **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 541 or consent of instructor. Instructors: Beratan, Warren, and Yang. 4 units.

543. **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.

544. **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 543 or consent of instructor. Instructors: Beratan, Charbonneau, MacPhail, and Yang. 4 units.


590. **Special Topics in Chemistry.** Special topics in chemistry and chemistry-related areas. Content varies by instructor. Instructor: Staff. 4 units.

590-1. **Special Topics in Chemistry.** Special topics in chemistry and chemistry-related areas. Content varies by instructor. Instructor: Staff. 2 units.

601. **Biosensors.** Theory and applications of biosensors. Basic principles of interactions between analytes and bioreceptors and various transduction techniques: optical, electrochemical, ion-selective electrode-based, voltammetric, conductometric, and mass-sensitive techniques as well as novel nanotechnology-based biosensing systems including nanosensors, plasmonic nanopores, quantum dots, carbon nanotubes, molecular beacons, and molecular sentinel systems. Applications in chemical, environmental, biological and medical sensing. Paired with Biomedical Engineering 567. Prerequisites: senior or graduate standing or instructor's consent. Instructor: Vo-dinh. 3 units.

630. **Advances in Photonics: An Overview of State-of-the-Art Techniques and Applications.** 3 units. C-L: see Biomedical Engineering 850

701S. **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.

760S. **Seminar.** One hour a week discussion. Credit/no credit grading only. Instructors: All members of the graduate staff. 1 unit.

801. **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.

990-0. **Special Topics in Analytical Chemistry.** Advanced topics and recent developments in analytical chemistry. Variable credit. 1 to 4 units. Instructor: Staff. Variable credit.

990-1. **Special Topics in Biological Chemistry.** Advanced topics and recent developments in biological chemistry. 1 to 4 units. Instructor: Staff. Variable credit.
990-2. Special Topics in Inorganic Chemistry. Advanced topics and recent developments in inorganic chemistry. Variable credit. 1 to 4 units. Instructor: Staff. Variable credit.


990-4. Special Topics in Physical Chemistry. Advanced topics and recent developments in physical chemistry. Variable credit. Instructor: Staff. Variable credit.

995. 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); Professor Woods, Director of Graduate Studies (229B Allen); Professors Antonaccio, Boatwright, Burian, Forte, Janan, Johnson; Associate Professors, Sosin, Woods; Assistant Professors Atkins, González, Jiménez; Professors Emeriti Clay, Davis, Newton, Rigsby, Stanley; Adjunct Associate Professors Dillon (art, art history and visual studies) and Ferejohn (philosophy)

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 coursework, directed research, and their own teaching, to prepare for careers in 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 http://classicalstudies.duke.edu.

Courses in Classical Studies (CLST)
524S. 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: Johnson or Sosin. 3 units. C-L: History 533S

528S. 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: Johnson or Sosin. 3 units. C-L: History 528S

532. 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 516

532S. 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. C-L: History 534S

536. The Roman Empire. The foundation, consolidation, and transformation of Roman rule from Augustus to Diocletian. Instructor: Boatwright. 3 units. C-L: History 538

536S. 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: Boatwright. 3 units. C-L: History 539S

541S. Greek Art and Society: Archaic To Classical. 3 units. C-L: see Art History 501S

542S. Greek Art: Hellenistic to Roman. 3 units. C-L: see Art History 502S
558S. Live Images: Ancient and Medieval Representations of the Divine. 3 units. C-L: see Visual and Media Studies 533S; also C-L: Religion 552S, Medieval and Renaissance Studies 507S

560. Etruscan Cities. Focuses on the concept and definition of city in Etruscan society and its socio-political role in territorial organization. Main topics include pre-urban and urban development of Etruscan society, the first settlements, space and rituals, formation and development of Etruscan City States, cities and landscapes, cultural models between Greeks and Etruscans, colonies and emporia, transformations and changes in Roman times. Primary evidence for all the above will be visualization of material remains from antiquity. Instructor: Forte. 3 units. C-L: Art History 561

568. 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 648

571S. Ancient Political Philosophy. 3 units. C-L: see Political Science 575S; also C-L: Philosophy 571

572S. Plato. 3 units. C-L: see Philosophy 511S

573S. Aristotle. 3 units. C-L: see Philosophy 512S

580S. Proseminar: Introduction to Classical Studies. Credit/no credit grading only. Instructor: Staff. 3 units.

590. Special Topics in Greek Art. 3 units. C-L: see Art History 590S-01

590LS. Special Topics in Roman Archaeology. Studies in Roman art and archaeology on focused themes, or on particular assemblages or problems. Offerings might include Art and Architecture of Pompeii, Roman Portraiture, etc. Includes laboratory component. Instructors: Boatwright, Forte, or Jiménez. 3 units. C-L: Art History 590S-10

590LS-1. Special Topics in Greek Archaeology. Focused studies in Greek archaeology on specific themes, assemblages or problems. Offerings might include Homeric Archaeologies, Greek Sanctuaries, Hero Cult, War and Commemoration, Western Greece, etc. Instructor: Antonaccio. 3 units. C-L: Art History 590S-11

690S. Special Topics in Classical Studies. Topic varies from semester to semester. Instructor: Staff. 1 unit.

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

724S. Seminar in Ancient History I (Topics). Selected topics. Instructor: Boatwright, Johnson, or Sosin. 3 units.

728S. Seminar in Ancient History II (Topics). Selected topics. Instructor: Boatwright, Johnson, or Sosin. 3 units.

744S. Archaeology Seminar I (Topics). Selected topics. Instructor: Antonaccio, Forte, or Jiménez. 3 units.

748S. Archaeology Seminar II (Topics). Selected topics. Instructor: Antonaccio, Forte, or Jiménez. 3 units.

790. Special Topics in Classical Studies. Special Topics in Classical Studies. Topics vary by semester. Instructor: Antonaccio or Staff. 3 units.

808S. Classical Studies Pedagogy. This weekly workshop examines in practical and theoretical terms both traditional and new methods in teaching ancient languages, ancient culture and history, and archaeology, including topics such as the role of technology in and out of the classroom, syllabus design, aims and methods of evaluation, classroom dynamics, lesson planning, teaching resources. Instructor: Staff. 1 unit.

Courses in Greek (GREEK)

504. Historians. 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: Johnson, Sosin, or Staff. 3 units.

508S. 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: Johnson, Gonzáles or Staff. 3 units.

524. 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: González. 3 units.

528. 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: Staff. 3 units.

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

582S. 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.

586S. 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: Johnson or Sosin. 3 units.

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

764S. Seminar in Greek Literature I (Selected Topics). Selected authors and topics. Instructor: González, Johnson, or Sosin. 3 units.

768S. 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: González, Johnson, or Sosin. 3 units.

Courses in Latin (LATIN)

504S. 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: Atkins, Boatwright or Davis. 3 units.

508S. Medieval and Renaissance Latin. Detailed study of selections from one or more authors or genres. Selections either constitute a survey of Latin literature from late antiquity through the Renaissance, or focus on specific locations or periods (e.g. Insular Writers, or the Carolingian "Renaissance", or the Long Twelfth Century). Authors and readings might include Augustine, Isidore of Seville, Bede, Einhard, Carolingian poetry, Hrotsvita, the Carmina Burana, Heloise and Abelard, Hildegard of Bingen, Petrarch, Lorenzo Valla, Leonardo Bruni. Topics may vary. Instructor: Woods. 3 units. C-L: Medieval and Renaissance Studies 608S

528S. 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: Janan or Davis. 3 units.

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

581S. Latin Prose Syntax and Style. Latin prose composition combined with analysis of the style and syntax of select Latin prose authors. Instructor: Davis. 3 units.

584S. 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 647S

585S. Latin Epigraphy. Introduction to the field of Latin 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 Latin texts, and to the original physical and social contexts of inscriptions. Instructor: Boatwright. 3 units.

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

764. Seminar in Latin Literature I. Selected authors and topics. Instructor: Atkins, Boatwright, Davis, Janan, or Woods. 3 units.
768S. Seminar in Latin Literature II. Selected authors and topics. Instructor: Atkins, Boatwright, Davis, Janan, or Woods. 3 units.

Cognitive Neuroscience
Professor Elizabeth Brannon, Director of Graduate Studies (B248A Levine Science Research Center)

This is an admitting program.
A certificate is also available in this program.

The Cognitive Neuroscience Admitting Program (CNAP) provides an interdisciplinary education in cognitive neuroscience. 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. This 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 Cognitive Neuroscience 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 CNAP program. Typical early coursework includes a two-week neuroscience bootcamp followed by a year-long core course in cognitive neuroscience. During their first year, students complete rotations in three laboratories, often chosen because they investigate different research topics or use diverse research methods. During their 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 CNAP 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, 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 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 websites.
- 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 http://www.dibs.duke.edu/education/graduate/cogneuro-ap/about.

College Teaching
Hugh Crumley, PhD, Program Director

A certificate is available in this program.

The Certificate in College Teaching (CCT) program, administered within The Graduate School is available for enrolled PhD students in any department or program of study. This program makes use of both departmental
training and resources as well as The Graduate School programming. The Certificate in College Teaching is being offered in order to recognize and validate professional development activities undertaken by PhD students and add competitiveness and value to PhDs awarded to Duke graduate students.

**The goals of the CCT program are to facilitate and recognize graduate students’ completion of**

- sustained, systematic pedagogical training that promotes;
- current best practices in teaching and learning;
- appropriate use of instructional technology;
- systematic assessment of student learning outcomes;
- a reflective teaching practice including peer observation; and
- development of materials suitable for use in applying for teaching positions after graduation.

**Requirements**

**Coursework**

Participants should successfully complete two courses in college teaching. This can include any combination of The Graduate School and/or discipline specific pedagogy courses offered by a department or program.

- **Graduate Studies courses**
  - Graduate Studies 750 (Fundamentals of College Teaching)
  - Graduate Studies 755 (College Teaching & Course Design) (syllabus & materials design, teaching statement)
  - Graduate Studies 760 (College Teaching & Visual Communication) (graphic & web design for teaching)
  - Graduate Studies 765 (College Teaching Practicum) (video recorded teaching demos)
  - Graduate Studies 770 (Topics and Careers in Higher Education) (job application materials)
  - Graduate Studies 302 (Introduction to College Teaching). No longer offered, but does count toward this requirement.
  - Graduate Studies 357 & 358 (Teaching Writing in the Disciplines). No longer offered but does count toward this requirement.
  - (Course deliverables listed after each course can be used in a teaching portfolio, the third requirement, below.)
- **Departmental pedagogy courses**
  - African and African American Studies 780S (Teaching Race, Teaching Gender) (crosslisted in women’s studies, history, literature)
  - Biology 705S (Seminar in Teaching College Biology)
  - English 890S (21st Century Literacies: Digital Knowledge, Digital Humanities) (crosslisted in information science and information studies)
  - German 700S (Foreign Language Pedagogy: Theories and Practices)
  - History 703S (Focusing on Teaching and Pedagogy)
  - Mathematics 771S (Teaching College Mathematics)
  - Philosophy 795S (Teaching Philosophy)
  - Political Science 790 (Teaching Politics)
  - Religion 996S (Teaching in Religion)
  - Romance Studies 700 (Theories and Techniques of Teaching Foreign Languages)
  - Russian 714 (Methods in Teaching Russian)
  - Statistical Science 790.04 (Special Topics: Teaching Statistics)
  - Women’s Studies 320 (The Pedagogy of Women’s Studies)

**Teaching experience and observation**

Participants should have formal experience teaching a group of students over the course of a term in a classroom or lab setting. Depending on the discipline and department, this could include serving as a teaching assistant with appropriate teaching responsibilities, leading a recitation section or lab, being a co-instructor of a course or being the primary instructor of record. With the approval of the CCT program director, other types of teaching experience may be used to fulfill this program requirement.

Students in the program should participate in teaching observations, both as a teacher being observed and as an observer of others teaching. In their teaching role, participants should be observed by at least two who provide brief written feedback. Observers can be faculty from the participant’s department or a related program, The Graduate
School staff, trained peer graduate students or others as approved by the program director. Participants should also conduct at least two observations of other faculty or graduate students teaching.

**Online teaching portfolio**

The online teaching portfolio can be created in any web authoring tool the participant is comfortable using (Word Press, Dreamweaver, Google Sites, etc.) It may include a current CV, a teaching statement and other materials as appropriate to the student's discipline. Note that students will create portfolio materials in the college teaching classes and as part of their teaching experience as described above in requirements one and two.

**Application information**

Applications can be made at any time for the program, which should take about a year to complete; this may vary, though, as opportunities for gaining teaching experience vary across departments. Typically, PhD students close to or beyond their prelims (or equivalent) would be well-situated to enroll. However, if you have teaching responsibilities early in your program (as in your first or second year), it would make sense to enroll then. The latest that an application can be made is before Drop/Add of the semester in which a PhD student intends to graduate; a much earlier application (as in at least a year or more before) is recommended.

For more information, visit [http://gradschool.duke.edu/prof_dev/cct/](http://gradschool.duke.edu/prof_dev/cct/) or contact Dr. Hugh Crumley, CCT program director at crumley@duke.edu.

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**Computational Biology and Bioinformatics**

Alexander Hartemink, Director (Department of Computer Science); Scott Schmidler, Director of Graduate Studies (Department of Statistical Science); fifty-seven 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 classroom training and engage in original research under the supervision of program faculty, who represent more than fifteen departments spanning biological and computational disciplines in the medical school and main campus.

The CBB program is explicitly designed to prepare students for the broad and rapidly evolving field of computational biology research. 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 the various disciplines that make up computational biology on campus.

The CBB core curriculum emphasizes the integration of biology and computation, as reflected in the syllabus of each core course, which includes lectures on quantitative principles and methods along with biological applications. The core courses taken by all CBB students include Computational Biology and Bioinformatics 520, Computational Biology and Bioinformatics 540, and one of Computational Biology and Bioinformatics 561, 662, or 663. In addition to the core courses, all CBB graduate students are expected to take several elective courses, within CBB and outside the program, in areas of biological and quantitative sciences related to their chosen research. In addition, all first and second-year students must register for Computational Biology and Bioinformatics 510S (Computational Biology Seminar) and Computational Biology and Bioinformatics 511 (Journal Club).

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 research rotations which provide an introduction to new research problems and methods in an immersive environment. Trainees conduct three rotations in their first year of study and choose a dissertation advisor at the end of the summer of their first year.

For additional information, visit [http://www.genome.duke.edu/CBB/](http://www.genome.duke.edu/CBB/) or e-mail cbbdgs@duke.edu.

**Certificate in Computational Biology and 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 520, 540, or 561/662/663); one additional computational biology and bioinformatics course and registration for Computational Biology and Bioinformatics 510S 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);
• one additional computational biology and bioinformatics course (for grade);
• register for Computational Biology and Bioinformatics 510S (Computational Biology and Bioinformatics Seminar), every semester except the semester of graduation; and
• appoint at least one member of the computational biology and bioinformatics faculty to their dissertation committee.

Courses in Computational Biology and Bioinformatics Courses (CBB)

510S. 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.

511. Journal Club. A weekly series of discussions led by students that focus on current topics in computational biology. Topics of discussion may come from 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. 1 unit.

520. 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.

540. Statistical Methods for Computational Biology. Methods of statistical inference and stochastic modeling with application to functional genomics and computational molecular biology. Topics include: statistical theory underlying sequence analysis and database searching; Markov models; elements of Bayesian and likelihood inference; multivariate high-dimensional regression models, applied linear regression analysis; discrete data models; multivariate data decomposition methods (PCA, clustering, multi-dimensional scaling); software tools for statistical computing. Prerequisites: multivariate calculus, linear algebra and Statistical Science 611. Instructor: Engelhardt, Mukherjee, or Schmidler. 3 units. C-L: Statistical Science 613

541. 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 504

550. Computational Structural Biology. 3 units. C-L: see Computer Science 664; also C-L: Statistical Science 614

561. Computational Sequence Biology. 3 units. C-L: see Computer Science 561

561L. Genome Science and Technology Lab (GE, MC). 3 units. C-L: see Biomedical Engineering 561L

573S. Modeling of Biological Systems. 3 units. C-L: see Mathematics 573S; also C-L: Modeling Biological Systems 573S

574. Modeling and Engineering Gene Circuits (GE, MC). 3 units. C-L: see Biomedical Engineering 574

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

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

612. Ethics and Policy in Genomics. 3 units. C-L: see Genome Sciences and Policy 612; also C-L: Public Policy Studies 634

622. Structure of Biological Macromolecules. 3 units. C-L: see Biochemistry 622; also C-L: Structural Biology and Biophysics 622

634. Geometric Algorithms. 3 units. C-L: see Computer Science 634

658. Structural Biochemistry I. 2 units. C-L: see Biochemistry 658; also C-L: Cell and Molecular Biology 658, Cell Biology 658, University Program in Genetics 658, Immunology 658, Structural Biology and Biophysics 658

659. Structural Biochemistry II. 2 units. C-L: see Biochemistry 659; also C-L: Cell Biology 659, Immunology 659, Structural Biology and Biophysics 659, University Program in Genetics 659

662. Computational Systems Biology. 3 units. C-L: see Computer Science 662
663. Algorithms in Structural Biology and Biophysics. 3 units. C-L: see Computer Science 663

700. Internship. Student gains practical experience by taking an internship 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.

720. Applications of high-throughput sequencing for genomic analysis. High-throughput sequencing has revolutionized our ability to study genomic function. In this class, students will learn how to design, perform, and analyze experiments to measure genome-wide changes in chromatin state, transcription factor occupancy, and gene expression. Topics will include approaches for constructing high-throughput sequencing libraries, data quality control, and statistical techniques to measure gene expression and to identify differential activity. Emphasis will be placed on computational analysis and hands on experience. Upon completion, students will have a strong foundation to design and analyze sequencing-based genomic assays in their own research. Prerequisites: Experience working in the UNIX environment and in a programming language of choice. Instructor: Tim Reddy. 3 units.

724L. 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.

726. Dynamic Modeling of Biological Systems. 3 units. C-L: see Biology 726

Computer Science

Professor Parr, Chair (D315 Levine Science Research Center); Associate Professor of the Practice Lucic, Associate Chair (D310 LSRC); Associate Professor Munagala, Director of Graduate Studies (D327 LSRC); Professors Agarwal, Bryant, Calderbank, Chakrabarty, Chase, Conitzer, Donald, Harer, Hartemink, Henriquez, Lebeck, Lenoir, Maggioni, Maggs, Parr, Reif, Rose, Sapiro, Sun, Tomasi, Trivedi, and J. Yang; Associate Professors Babu, Board, Cox, Dwyer, Ferrari, Kim, Mukherjee, Munagala, Ohler, Schmidler, Sorin, and X. Yang; Assistant Professors Benson, Engelhardt, Farsiu, Godn, Heller, Lee, Machanavajjhala, and Panigrah; Professors Emeriti Biermann, Ellis, Gallie, Loveland, Patrick, Ramm, Starmer, and Wagner; Professors of the Practice Astachan and Rodger; Associate Professors of the Practice Forbes and Lucic; Assistant Professor of the Practice Hilton; Adjunct Professors Arge, Balinde, Edelsbrunner, Fowler, Hsu, Labeau, Lombardi, Mölhave, Pitsianis, Pormann, and Roy Choudhury; Adjunct Senior Research Scientist Brady; 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 an option involving coursework only (30 graded course credits) or an option involving a combination of coursework (24 graded and up to 6 ungraded course 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. The MS course program includes advanced courses in the declared area of concentration, and courses in a related field of study. The PhD course program includes a breadth requirement, 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 701S) 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, algorithms, 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 algorithms and computational complexity; computational geometry; internet systems, networking and security; computer architectures and distributed systems; computational biology; biological computing and nanotechnologies; databases, mobile, and cloud computing; learning and modeling; artificial intelligence, computational economics, computer vision, sensor networks, and scientific computing provide exciting and challenging research opportunities to students in computer science. The research interests of our faculty overlap
with these areas and with research areas in other disciplines such as biology, engineering, nanotechnology, environmental sciences, economics, biochemistry, statistics, and medicine.

**Courses in Computer Science (COMPSCI)**

510. 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.

512. 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 210 or 510 and Computer Science 514, or consent of the instructor. Instructor: Chase, Cox, or Maggs. 3 units.


515. Wireless Networking and Mobile Computing. 3 units. C-L: see Electrical and Computer Engineering 556

516. 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 516 or an introductory database course or consent of instructor. Instructor: Babu or J. Yang. 3 units.


524. Nonlinear Dynamics. 3 units. C-L: see Physics 513

527. Introduction to Computer Vision. Image formation and analysis; feature computation and tracking; image motion analysis; stereo vision; image, object, and activity recognition and retrieval. Prerequisites: Mathematics 221 or 216; Mathematics 230 or Statistical Science 230; Computer Science 101. Instructor: Tomasi. 3 units.

528. Introduction to Computational Science. Introduction to scientific computing and its applications to facilitate interdisciplinary collaborative research. Brief intro to contemporary high performance computer architectures, basic linear algebra, numerical analysis, programming languages and widely available software packages. Study high performance algorithms in finite elements, fast transforms, molecular dynamics, high dimensional optimization, computational quantum mechanics and visualization. Parallel lab sessions by experts offer further specialization. Prerequisite: programming experience in Fortran or C, calculus, numerical linear algebra or equivalent. Instructor: Staff. 3 units.

532. 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. Prerequisites: Computer Science 201 and 330 or equivalent. Instructor: Agarwal, Munagala, Panigrahi, or Reif. 3 units.

534. 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 334 or equivalent. Instructor: Agarwal or Reif. 3 units.
550. 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 250 or Electrical and Computer Engineering 350 or equivalent. Instructors: Board, Lebeck, or Sorin. 3 units. C-L: Electrical and Computer Engineering 552

553. Compiler Construction. 3 units. C-L: see Electrical and Computer Engineering 553

554. Fault-Tolerant and Testable Computer Systems. 3 units. C-L: see Electrical and Computer Engineering 554

555. Probability for Electrical and Computer Engineers. 3 units. C-L: see Electrical and Computer Engineering 555

561. 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 530 or equivalent), probability and statistics (Statistical Science 611 or equivalent), molecular biology (Biology 118 or equivalent). Alternatively, consent instructor. Instructor: Hartemink. 3 units. C-L: Computational Biology and Bioinformatics 561

570. Artificial Intelligence. Design and analysis of algorithms and representations for artificial intelligence problems. Formal analysis of techniques used for search, planning, decision theory, logic, Bayesian networks, robotics, and machine learning. Prerequisite: Computer Science 201 and Computer Science 330. Instructor: Conitzer or Parr. 3 units.

571D. Machine Learning. Theoretical and practical issues in modern machine learning techniques. Topics include statistical foundations, supervised and unsupervised learning, decision trees, hidden Markov models, neural networks, and reinforcement learning. Minimal overlap with Computer Science 570. Prerequisite: Computer Science 201, Mathematics 221, and Statistical Science 111 or consent of instructor. Instructor: Parr. 3 units.

579. Statistical Data Mining. 3 units. C-L: see Statistical Science 622

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

624. Nanoscale and Molecular Scale Computing. 3 units. C-L: see Electrical and Computer Engineering 611

630. 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 530. Instructor: Agarwal, Munagala, or Reif. 3 units.

632. 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.

634. Geometric Algorithms. 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 530 or equivalent. Instructor: Agarwal. 3 units. C-L: Computational Biology and Bioinformatics 634

636. 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 530. Instructor: Harer. 3 units. C-L: Mathematics 619
650. Advanced Computer Architecture II. Parallel computer architecture design and evaluation. Design topics include parallel programming, message passing, shared memory, cache coherence, memory consistency models, symmetric multiprocessors, distributed shared memory, interconnection networks, and synchronization. Evaluation topics include modeling, simulation, and benchmarking. Prerequisite: Computer Science 550 or Electrical and Computer Engineering 552 or consent of instructor. Instructor: Lebeck or Sorin. 3 units. C-L: Electrical and Computer Engineering 652

662. 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 530 or equivalent), probability and statistics (Statistical Science 611 or equivalent), molecular biology (Biology 201L or equivalent), and computer programming. Alternatively, consent of instructor. Instructor: Hartemink. 3 units. C-L: Computational Biology and Bioinformatics 662

663. 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: students should have some familiarity with algorithms, and a basic knowledge of molecular biology. Alternatively, consent of instructor. Instructor: Donald. 3 units. C-L: Computational Biology and Bioinformatics 663

664. 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 (Statistics 611 and 721 or equivalent), molecular biology (Biology 118 or equivalent), and computer programming. Alternatively, consent of instructor. Instructor: Schmidler. 3 units. C-L: Computational Biology and Bioinformatics 550, Statistical Science 614

673S. Computer Models and the Treatment of Psychiatric Disorders. 3 units. C-L: see Psychology 673S; also C-L: Information Science and Information Studies 673S, Pharmacology and Cancer Biology 673S

701S. 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.

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

724. Advanced Topics in Nonlinear and Complex Systems. 3 units. C-L: see Physics 813

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

770S. 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.

776. 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 570. Instructor: Biermann or Loveland. 3 units.

791. 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.

805. 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 520 and 252. Instructor: Greenside, Rose, or Sun. 3 units.

Cultural Anthropology

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

The department offers graduate work leading to the PhD degree in cultural anthropology. It also participates in a program with Duke 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 coursework, 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: Cultural Anthropology 801 and 802 (Theories in Cultural Anthropology), required of first-year graduate students, and research/grant writing seminar Cultural Anthropology 804 (Grant Writing), required in the fourth and fifth 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 website at http://culturalanthropology.duke.edu.

Courses in Cultural Anthropology (CULANTH)

501S. Anthropology and History. Recent scholarship that combines anthropology and history, including culture history, ethnohistory, 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: Staff. 3 units. C-L: History 572S, Romance Studies 521S

525S. 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 or cultural theory recommended. Instructor: Starn and Stein. 3 units. C-L: International Comparative Studies 525S

530S. 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.

535S. Race, Racism, and Democracy. The paradox of racial inequality in societies that articulate principles of equality, democratic freedom, and justice for all. Instructor: Baker. 3 units. C-L: African and African American Studies 545S

539S. Queer China. 3 units. C-L: see Asian & Middle Eastern Studies 539S; also C-L: Women's Studies 502S, Literature 539S, Arts of the Moving Image 539S, Visual and Media Studies 539S
540S. 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: Staff. 3 units. C-L: Women's Studies 581S

545S. 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.

555S. 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: Starn. 3 units.

560S. African Modernities. 3 units. C-L: see African and African American Studies 645S

561S. Africa in a Global Age. Africa's participation in globalization has not simply been a matter of "joining the world economy." Rather, Africa's inclusion has been selective, uneven, and partial. This is quite a different proposition 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 retracing the history of globalization, beginning with the Atlantic trade in human beings and concluding with an account of Africa's place in the global circulation of people things, ideas, and currencies in early twenty-first century. Instructor: Makhulu. 3 units. C-L: African and African American Studies 510S, History 561S, Political Science 527S, International Comparative Studies 510S

563S. Nightmare Japan. 3 units. C-L: see Asian & Middle Eastern Studies 563S

565. The World of Japanese Pop Culture. 3 units. C-L: see Asian & Middle Eastern Studies 565

570S. 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 540S, Literature 573S

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

590S. Seminar in Selected Topics. Same as Cultural Anthropology 590 except instruction provided in seminar format. Instructor: Staff. 3 units.

594S. Cultural (Con)Fusions of Asians and Africans. 3 units. C-L: see African and African American Studies 594S; also C-L: Latin American Studies 594S, Sociology 594S

605. East Asian Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 605; also C-L: Literature 571, International Comparative Studies 605

611. Global Mental Health. 3 units. C-L: see Global Health 660; also C-L: Psychology 611

641S. Citizen and Subject in a Neoliberal Age. 3 units. C-L: see African and African American Studies 641S; also C-L: Sociology 645S

705S. 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.

706S. Popular Culture: Theory and Ethnography. This courses studies influential theories of popular and commodity culture from the last century, including the work of Marx and Gramsci, scholars of the Frankfurt school (Benjamin, Adorno), Birmingham School (Hall, Gilroy, Williams), and two decades of ethnographic scholarship (Gingsburg, Larkin, Varzi). We will place considerable emphasis on themes of media and mediation, visibility and the image, the human and the machine, and the digital. Instructor: Stein. 3 units.
710S. 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: Staff. 3 units.

715S. 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.

716S. Capitalism. This course introduces students to some of the debates relating to the current financial crisis—both within and beyond the field of finance itself. Combining media accounts with scholarly critiques of the current structures for money making, this course is primarily committed to theorizing the culture of capitalism in the early 21st Century. The larger inter-disciplinary framework for the course encompasses inter-related fields of inquiry including anthropology, cultural geography, and political economy. Instructor: Makhulu. 3 units. C-L: Sociology 716S, Political Science 720S

720S. 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.

725S. 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.

726S. Governmentality. Governmentality - a concept articulated by the French historian and philosopher Michel Foucault (1926-1984) - has become a key analytic of much recent critical writing in cultural anthropology. Taking governmentality as a point of departure, this graduate seminar will investigate governmentality as an analytical framework oriented towards interpreting our world. We will consider works by anthropologists, and scholars in related fields, who have drawn on Foucault's methods and concepts in relationship to a wide range of socio-political, philosophical and historical thought, and critically engage their attempts to deploy his approach in ethnographic analysis. Instructor: McIntosh. 3 units.

727S. Dissertation Writers' Workshop. Weekly seminar for Cultural Anthropology students who have returned from fieldwork and are in the process of writing up their dissertations. Each seminar will focus on a particular aspect of anthropological writing: the introduction and conclusion to a thesis, for example, or when/where/how to lay out methodology, literature review, and positionality. As integrating ethnography and theory is particular to our discipline, emphasis will be placed on examining different strategies, techniques, styles, and tropes for doing this. Instructor: Staff. 3 units.

728S. Development: History, Theory, Politics. Examines development as history, as theory, and as politics with a focus on the postcolonial world. Considers development as knowledge and political economy, as a technology of subject formation and a locus of collective mobilization, and as a project of rule and rights. Instructor: Subramanian. 3 units.
729S. Space and Power. Through readings of ethnographic and historical monographs, and theoretical essays from the discipline of geography, we will examine the spatial production of social worlds and how this process has unfolded in varied cultural and historical settings. Instructor: Subramanian. 3 units.

730S. Studies in Ethnomusicology. 3 units. C-L: see Music 790S-2

735S. Anthropology and History. 3 units. C-L: see History 850S

740S. 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: Literature 735S

741S. Globalization. "Globalization" is variously described in terms of the integration of markets, the increasing velocity of transactions, the opening up of new geographies for capital accumulation, de-regulation, and so on. This course looks to the Atlantic world as a starting point in understanding the rise of modern capitalism—by way of the slave trade, the rise of finance capital, and the circulation of objects, ideas and people. This course goes on to questions relations of debt and dispossession; novel forms of governance and governmentality; flexibility and superfluity; and growing inequalities and constraints of late capitalism. Instructor: Makhulu. 3 units. C-L: African and African American Studies 741S

742S. Nature/Culture. What are the frontiers of the nature/culture debates? What is their lineage in cultural and critical theory? And how do these debates unfold in the practice of ethnography and in ethnographic writing? These three questions guide this graduate seminar, whose topic for 2013 will be "Objects and Environments." Foundational readings may include works by Strathern, Serres, Canguilhem, Tsing, Bateson, Latour, Haraway, and Barad, and will be put into conversation with a series of recent ethnographies. Seminar participants will be responsible for writing weekly reading notes, guiding course discussions, and writing a final research paper. Instructor: Solomon. 3 units.

743S. Anthropology of Media and Mediation. This graduate seminar introduces students to anthropological scholarship on the politics of media. We begin with classic theoretical works on mass media the early twentieth century and progress to contemporary anthropological scholarship on the interplay between media, culture, and politics. Our seminar will pay particular attention to issues of photography and visuality; media and/of war; technologies of witnessing; the cultural politics of music and sound; media and globalization; social media and grassroots politics. This graduate seminar will focus on professionalizing strategies, culminating in a proto-publishable research paper that draws on class material. Instructor: Stein. 3 units. C-L: Visual and Media Studies 743S, Art History 743S

744S. Mobility. This seminar explores theories (e.g. Locke on portable property), vehicles (boats), travellers (pirates, pilgrims, migrants), media (books, money, gravestones, genealogies) to recognize the phenomenon of mobility and its consequences. The historical expansion of western state and trade forms will be a major theme, contrasted with non-western mobilities. The course emphasises external rather than internal social relations. Instructor: Ho. 3 units.

745S. 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.

750S. 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: Staff. 3 units.

755S. 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.
Developmental Psychology

Professor Brannon, Director of the Developmental Program (B203 LSRC)

A certificate is available in this program.

The facilities in developmental psychology at Duke University and The University of North Carolina at Chapel Hill 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 nonhome 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 nonhome institution, for at least six semesters:
  - Center for Developmental Science talks;
  - Center for Child and Family Policy talks;
  - Colloquium series at both universities;
  - Developmental research and current topics groups, which meet regularly at both universities; or
  - Other program-affiliated events in the future.

Fulfill two of the following:

- Complete a minimum of two developmentally relevant psychology for-credit courses, taken at the student's nonhome institution (a relevant home institution course co-taught by nonhome institution faculty would count).
- 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 nonhome institution.
- Participation in a research activity with a developmental faculty member from the nonhome 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).
Developmental and Stem Cell Biology

Associate Professor David Sherwood, Director of Graduate Studies

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 Cell and Molecular Biology 551 (Cell and Molecular Biology) and University Program in Genetics 778 (Genetic Approaches to the Solution of Biological Problems). Each of these courses offers twenty-four different focus areas. Over the course of the semester, a student will take six focus areas (modules) of their choosing for both Cell and Molecular Biology 551 and University Program in Genetics 778. We encourage students to take at least six modules with a developmental focus. 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 Cell Biology 830 (Developmental 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 coursework 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.

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

Earth and Ocean Sciences

Professor McGlynn, Chair (109A Old Chemistry); Professor Haff, Director of Graduate Studies (321B Old Chemistry); Professors Baker, Boudreau, Chameides, Haff, Jackson, Klein, Liozier, Marani, McGlynn, Murray, Pratson, Vengosh; Associate Professor Cassar; Associate Professors of the Practice Golden and Johnson; Assistant Professor Li; Adjunct Faculty Erickson, Hegerl, Isaksen, Malin, Stanislaw; Professors Emeriti Barber, Corliss, Heron, Perkins, Pilkey, and Schlesinger

The Division of Earth and Ocean Sciences offers research opportunities in three broad areas of geoscience: biogeosciences, oceans and climate, and earth resources. Biogeosciences in EOS focuses on the interactions between life, water and landscapes including coastal ecomorphodynamics and remote sensing, watershed ecohydrology, and landscape evolution including that of coupled human-landscape systems. Oceans and climate research in EOS includes ocean circulation, atmospheric dynamics, paleoclimatic/paleoenvironment reconstruction, marine biogeochemistry, and ocean/atmosphere interactions, particularly as they relate to global climate change. And research in earth resources addresses the geologic formation and human use of mineral, energy, water, and land resources, including mineral formation, life-cycle analysis, energy consumption/emissions, water quality as it relates human health, and the role of technology in the Anthropocene.

Laboratory facilities available in the department are described in this bulletin under the chapter "Resources for Study" on page 355.

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 course credits 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 an MS degree while working toward the PhD degree. If this option is elected, the requirements are the same as for the MS program in terms of coursework, 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 at [http://www.nicholas.duke.edu/eos/](http://www.nicholas.duke.edu/eos/).

For further information on the graduate program, e-mail dgs@eos.duke.edu.

**Courses in Earth and Ocean Sciences (EOS)**

**507S. The Amazon: Geology, Climate, Ecology, and Future Change.** This course will study the natural history of the Amazon including its biodiversity, geological evolution, and modern climate and hydrology. The present development of the Amazon and best strategies for its future conservation will be discussed. Instructor: Baker. 3 units.


**509S. 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.

**510S. 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.

**511. 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.

**512. 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 handling as a means to an end of quantifying climate system behavior. Pre-requisite: Earth and Ocean Sciences 511. Instructor: Li. 3 units.

**514. Energy and Ecology.** Develop understanding of interactions between energy and ecology. Examine ecological effects of energy use, production and waste products. Examine ecological consequences of energy use broadly, and discuss potential consequences of science and policy decisions. Prerequisite: introductory college course in ecology or equivalent. Instructor: Jackson. 3 units.

**515. Mountain Ecohydrology Field Course -Montana.** Study of watershed ecohydrology and the interactions and feedback among hydrological and ecological processes in the western United States. Includes required pre-semester week-long field trip to Montana (with required fee), where participants visit active research watersheds, some of the most intensively instrumented ecohydrological research sites in the country. Students learn techniques to collect
hydrologic and ecological field data and work with instructors to collect a comprehensive suite of ecohydrological data, to be interpreted and presented during series of follow-up class meetings. Prerequisite: General background in Earth and Environmental Sciences. Instructor: McGlynn. 3 units.

520. 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.

524. Water Quality Health. Explore basic concepts of water quality and human health with focus on the global water cycle, global water demand and availability, chemical properties of water, contaminants in water, health implications, and environmental isotope hydrology. Highlights relationships between human activities, water scarcity, water quality degradation, and ecological and health consequences. Addresses some policy implications related to conflicts over water resources and impact of energy production on water resources. Prerequisites: prior knowledge of introductory calculus and chemistry or consent of instructor. Instructor: Vengosh. 3 units. C-L: Environment 524, Global Health 534, Energy 524

525. 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.

526S. 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.

527. 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.

528S. Biological-Physical Couplings in Coastal Environments; Responses to Changing Forcing. Focus on select examples of biological-physical couplings that shape coastal environments (i.e. coastal "ecomorphodynamics") and help determine how those environments respond to changing climate and land use. Environments include: barrier islands, tidal wetlands. Grading based on in-class presentations, and a final project (in the form of a research proposal). Instructor consent required. Instructor: Murray. 3 units.

530. Remote Sensing in Coastal Environments. Introduction to the field of remote sensing and image processing with focus on applications to coastal monitoring and currently open research questions. Students will acquire an operational knowledge of various remote-sensing tools and data types, with emphasis on their application in coastal areas. Content will include theory, in-class laboratory exercises, and projects with environmental applications. Prerequisite: introductory or AP physics preferred or permission of instructor. Instructor: Silvestri. 3 units. C-L: Environment 530, Civil and Environmental Engineering 574


542S. 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.

543S. 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 101 or consent of instructor. Instructor: Haff and Pratson. 3 units.

544S. 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.

545S. Nanoenvironment. 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.

551S. 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: Baker. 3 units.

567. 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.

569. Thermodynamics of Geological Systems. Introductory thermodynamics applied to geologic problems through understanding of phase equilibrium. Prerequisites: Earth and Ocean Sciences 201; and Mathematics 122 or consent of instructor. Instructor: Boudreau. 3 units.

571. 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 210DL and Mathematics 122. Instructor: Baker or Vengosh. 3 units.

573S. 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.

575S. Mineral Resources. Introduction to the mineralogy, geological setting, and genesis of metallic and nonmetallic 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.


579LA. Biological Oceanography. Variable credit. C-L: see Environment 579LA; also C-L: Biology 579LA

590. Special Topics in Earth and Ocean Sciences. Content to be determined each semester. Consent of instructor required. Instructor: Staff. Variable credit.

590S. Special Topics in Earth and Ocean Sciences. Content to be determined each semester. Consent of instructor required. Instructor: Staff. Variable credit.

715. Introduction to Coastal Environmental Change 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. Instructor: Murray. 3 units.

716A. 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 315/515 or consent of instructor. Also taught as Earth and Ocean Sciences 316A. Instructor: Murray. 2 units.

**722. Hydrologic and Environmental Data Analysis.** Course will focus on acquisition of skills necessary to extract information from observations of hydrological and environmental processes, connect the extracted information with the physical processes generating the data, and estimate physical quantities at ungauged location/times. Emphasis on process understanding via data analysis techniques. Applications used as a way to understand the general concepts, with examples drawn from water science. Prerequisites: Basic computer skills, Algebra, Calculus are required. Experience with computational software (e.g. Matlab or R) is helpful but not required. Instructor: Marani. 3 units.

C-L: Environment 722, Civil and Environmental Engineering 761

**723. Landscape Hydrology.** An introduction to hydrology by examining how rainfall and snowmelt become streamflow, evapotranspiration, and groundwater with emphasis on hydrological processes inside watersheds. Topic areas include: hydrologic cycle and water balances, evapotranspiration and snow energy balances, vadose zone hydrology, hydrogeology, hyporheic zones, riparian zones, streamflow generation mechanisms, biogeochemical budgets, and field measurement techniques. Linkages between physical hydrology and broader ecological and environmental sciences will be highlighted. Includes local field trips. Instructor: McGlynn. 3 units.

**790. Special Topics in Earth and Ocean Sciences.** Content to be determined each semester. Consent of instructor required. Instructor: Staff. 3 units.

**790S. Advanced Topics in Geology.** Topics, instructors, and credits to be arranged each semester. Instructor: Staff. Variable credit.

**791. Independent Study.** Consent of instructor required. Instructor: Staff. Variable credit.

**791-1. Independent Study.** Half credit version of EOS 791. Consent of instructor required. Instructor: Staff. 0.5 units.

**820. Earth and Ocean Science College Teaching Practicum.** Course for doctoral students to gain practical skills and knowledge while teaching. Reserved for Earth and Ocean Science Doctoral Students. Instructor: Staff. 3 units.

**890A. Advanced Topics in Earth and Ocean Sciences.** To meet the individual needs of graduate students for independent study. Instructor: Staff. Variable credit.

**990A. Advanced Topics in Earth and Ocean Sciences.** To meet the individual needs of graduate students for independent study. Instructor: Staff. Variable credit.

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**East Asian Studies**

Professor Troost, *Director of Graduate Studies*; Professors Allison, Chow, Conceison, Gao, Gereffi, Horowitz, Keister, Kim, Liu, Niou, Partner, Weisenfeld, Wong, Zeng; Associate Professors Abe, Ching, Endo, Hong, Jaffe, Ku, Lee, Litzinger, Mazuka, Mazumdar, Merli, Malesky, Rojas, Wilson; Assistant Professors Kim, Kwon and Xu; Visiting Associate Professor Chow

An MA or certificate is available in this program.

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 pursue doctoral programs. The temporal focus of the program is on the nineteenth and twentieth centuries, with fields of specialization available in art, art history, and visual studies, cultural anthropology, history, modern literature, political science, psychology, religion, and sociology. Past students in the program have explored cultural and literary studies, development and policy studies, film, media and visual studies, East Asian colonialism, gender, sexuality and ethnicity, institutional transformation, and politics and society. A track in critical Asian humanities (CAH) is available for students interested in cultural studies and critical theory. The program encourages the crossing of traditional disciplinary boundaries through interdisciplinary study while retaining a firm grounding in a disciplinary base.

**Degree Requirements**

The master’s degree in East Asian Studies requires ten courses (30 course credits, including an integrated required core course), of which at least eight (24 course credits) must be graduate-level East Asian Studies courses.
These must be drawn from a list of approved courses, with no more than four (12 course credits) taken in any one department. Two language courses (6 course credits) may be counted as part of the ten courses needed for the degree. In lieu of a thesis, each student, after consulting with his/her advisor, will submit a research paper to their capstone committee, composed of three faculty, at least two of whom must be from the APSI core faculty list. The degree is dependent on the acceptance of the research paper and successful completion of an oral examination on this paper by the capstone committee. The APSI director of graduate studies, along with an individual faculty advisor, directs students in their course of study. The capstone project 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.

**Critical Asian Humanities Track**

Requires ten courses (30 course credits), of which at least eight (24 course credits) must be at the 500-level or above. At least five (15 course credits) of the required ten courses for the MA must be literature/culture courses taken through AMES. Requirements for language proficiency and an integrated core course are the same; the capstone requires that two faculty members be drawn from AMES.

**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 graded graduate courses focusing on East Asia and 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 The Graduate School courses, rather than Duke 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 complete at least four courses from an approved list of courses in East Asian Studies, from at least two different departments or programs, and demonstrate proficiency equivalent to two years of college-level study 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.

For more information, visit [http://web.duke.edu/apsi/](http://web.duke.edu/apsi/).

**Courses in East Asian Studies Offered By Departments and Professional Schools**

**Art History (ARTHIST)**
590S-6 Topics in Chinese Art
590S-7 Topics in Japanese Art
716S Fascism East and West: The Visual Culture of Japan, Germany and Italy
722S. Experimental Art in a Global Context: 1989-Present
790-1 Topics in Japanese Art

**Arts of the Moving Image (AMI)**
641. Documentary and East Asian Cultures.

**Asian & Middle Eastern Studies (AMES)**
502S. Translation Studies and Workshop.
503. Modern Chinese Cultural Studies
503S. Modern Korean Buddhism
504S East Asia’s Twentieth Century
511. Documentary and East Asian Cultures.
515S. Interethnic Intimacies: Production and Consumption
533. Traffic in Women: Cultural Perspectives on Prostitution in Modern China
535. Chinese Media and Pop Culture.
539S. Queer China
561. Anime: Origins, Forms, Mutations
563S. Nightmare Japan.
565. The World of Japanese Pop Culture
605. East Asian Cultural Studies.
610. Trauma in Asia
611. Melodrama East and West.
631S. Seminar on Modern Chinese Cinema
632S. Literati/Literature Culture: Pre Modern Chinese Literature
665. Girl Culture, Media, and Japan.
669S. Minor Japan.
673. Trauma and Passion in Korean Culture.
738. Theories of Minority Discourse

Cultural Anthropology (CULANTH)
523S. Millennial Capitalisms: Global Perspectives.
590S. Ethnography of China.
605. East Asian Cultural Studies
671. World of Korean Cinema
791. Environmentalism in China
793. Global Tibet

Dance (DANCE)
255. Tai Chi and Chinese Thought.
356. Dance and Dance Theater of Asia.
367. Dance and Religion in Asia and Africa.
368. Gender in Dance and Theatre.

Documentary Studies (DOCST)
511. Documentary and East Asian Cultures.

Economics (ECON)
542S. Social Change, Markets, and Economy in China.
548S. Political Economy of Growth, Stabilization, and Development.

History (HISTORY)
502S. Japan since 1945
504S. East Asia's Twentieth Century
507. Introduction to Asian Studies
535S. Camera Asia
582S. Narrative, History, and Historical Fiction.
791. Globalization, Women, and Development: China, South Korea, and India
890S-05. Research in Global Connections.
890S-01. Research Topics in African and Asian History

Law
508. Chinese Law and Society
509. Chinese Legal History.
605. Chinese for Legal Studies

Literature (LIT)
571. East Asian Cultural Studies.

Political Science (POLSCI)
560S. International Relations Theory and Chinese Foreign Policy
590. Special Topics: Japanese Politics
619. Media and Social Change.
645S. Political Economy of Growth, Stabilization, and Development

Public Policy (PUBPOL)
598. Economic Growth and Development Policy
676. Media and Social Change.
820. Globalization and Governance

Religion (RELIGION)
680S. Buddhist Thought and Practice.
999-05. Asian Religions; Transnationalism and Modernity

Sociology (SOCIOL)
541. The United States and the Asia-Pacific Region
650S. Global Responses to the Rise of China.
651S. Social Change, Markets, and Economy in China.
690S. Seminar in Selected Topics: Chinese Economic Development in Comparative Perspective.
690S. U.S. – China Relations
730S. Topics in Comparative and Historical Sociology: Globalization and Comparative Development
A PhD and a graduate 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/.

Courses in the University Program in Ecology (UPE)

701. Ecological perspectives: Individuals to communities. Enrollment: Ph.D. students only. 4 units. C-L: Biology 841, Environment 841

702. Ecological perspectives: Ecophys to Ecosystems. A comprehensive course on the processes and factors that determine the capture and flow of energy and materials through individual organisms, populations, and entire
ecosystems, both natural and disturbed. Interactions between ecosystem processes and the determinants of species number, and home range link this course to material covered in University Program in Ecology 701. Focus on human impacts that affect the movements of energy and materials in ecosystems. Studies of paleoecology provide a historical context for current patterns of global change. Instructor: Staff. 4 units. C-L: Biology 842, Environment 842

703S. Ecology Seminar. Presentation of current research by faculty and students in the University Graduate Program in Ecology. Instructor: Staff. 1 unit.

Economics

Professor Bayer, Chair (213 Social Sciences); Professor Taylor, Director of Graduate Studies (315 Social Sciences); Professor Kimbrough, Director of MA Studies and Professor of Economics (312 Social Sciences); Professors Abdulkadir-iroglu, Adler, Ambrus, Anton, Arcidiacono, Ariely, Bansal, Bollerslev, Burnside, Clotfelter, Cohen, Coleman, Conitzer, Cook, Darby, De Marchi, Frankenberg, Gallant, Goodwin, Hoover, Hotz, Hsieh, Jaimovich, Khan, Kimbrough, Kramer, Kranton, Kuran, Ladd, Lewis, Lopomo, Marx, McAdams, McElroy, Munger, Nechyba, Newell, Pattanayak, Patton, Peretto, Pfaff, Rampini, Rubio-Ramirez, Sanders, Sloan, Tauchen, Taylor, Thomas, Timmins, Tower, Vigdor, Viswanathan, and Weintraub; Associate Professors Bugni, Conrad, Daley, Field, Hamilton, Leventoglu, Sarver, Smith, Sweeting, and Yildirim; Assistant Professors Ananat, Bellemare, Feldman, Bischof, Chi, Chen, Dix-Carneiro, Garlick, Hamoudi, Ilut, Leventoglu, Li, Macartney, Masten, Maurel, Mohan, Ridley, Roberts, Sadowski, Serrato, Wang, and Xu; Professors Emeriti Burmeister, Grabowski, Graham, Kelley, Naylor, Treml, and Wallace; Research Professors Becker, Caldwell, and Toniolo; Professors of the Practice Leachman and Connolly; Associate Professor of the Practice Rasiel; Senior Research Scholars Boyd

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

Students preparing to enter these programs will find an undergraduate background in mathematics, engineering, computer science, 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), econometrics, 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.

The MA program requires a minimum of 30 graded course credits in economics and related fields. Students can choose from concentrations in either economics or one of two finance specializations: financial economics or applied financial economics. Within each of the two major areas of concentration, students’ course selections are based on their specific interests and on “track” recommendations made by their academic advisors in order to meet their longer-run goals. Courses offered through The Graduate School, listed as “GS” courses, do not count toward the 30-course credit requirement.

All MA students must complete a minimum of three courses (9 course credits) in microeconomics and macroeconomics. Any combination of three courses in micro and/or macro at the 600-level or higher offered by the economics department satisfy this requirement. They also are required to complete a minimum of three courses (9 course credits) in econometrics, computational methods, computer science, mathematics, and/or statistics with at least one course in econometrics. Any econometrics or computational methods courses at the 600-level or higher offered by the economics department count toward this requirement. Courses in computer science, mathematics, and statistics at the 600-level or higher as well as select courses at the 200-499 level also satisfy this requirement. However, students may not use undergraduate level (200-499) courses in the economics department toward the econometrics requirement. A maximum of 6 course credits (two courses) may be undergraduate courses at the 200-level or above (200-499), subject to academic advisor approval. Students must receive a grade of B- or better to have such courses counted as part of their earned graduate credit. At least five courses (15 course credits) must be in economics. This includes the courses listed below. At least one course (3 course credits) must be an approved capstone, and students are required to receive a B grade or better in this course. Students who choose the applied financial economics concentration are required to do an internship for their capstone course. Any course substitutions must be approved by the director of MA studies.

MA students must pass a final exam administered by their committee covering a portfolio of learning and research activities carried out during their master’s studies. The portfolio must include one of the following two items: a capstone course in either economics or statistical science, or a written master’s thesis or project report on an
approved topic developed via independent study with one or more economics and/or statistical science faculty advisors if available. This document is expected to describe a mature project with research content.

For additional information, please visit http://www.econ.duke.edu/.

Courses in Economics (ECON)

502S. Law, Economics, and Organizations. 3 units. C-L: see Public Policy Studies 602S

503S. Microeconomics of International Development Policy. 3 units. C-L: see Public Policy Studies 603S

505. International Trade and Policy. 3 units. C-L: see Public Policy Studies 605

506. Macroeconomic Policy and International Finance. 3 units. C-L: see Public Policy Studies 606

507. The Uses of Economics. The various ways economics is used in contemporary society: in the scholarly community, government, private sector, civil society, other disciplines, and popular culture. Readings in original texts and interpretative commentaries. Combined with Economics 311, this course may yield a written product suitable for submission for graduation with distinction. Graduate pairing for Econ 313; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

512. Equity Valuation and Financial Statement Analysis. High-level course for those who have previously had experience in corporate finance and accounting. Designed to give the student a deeper insight into important concepts relating to equity valuation and financial statement analysis, including such topics as international standards conversion, tax implications, long term liabilities and leases, and employee compensation. Prerequisites: Economics 174, and either Economics 372 or Economics 373. Instructor: Brown. 3 units.

513. Structuring Venture Capital and Private Equity Transactions. Design and implementation of corporate merger and acquisition transactions, including acquisitions of stock and assets of non-public corporations and acquisitions of publicly-held corporations in negotiated and hostile transactions. Covers federal securities law and state corporate law issues, including important forms of private ordering, such as poison pills, lock-ups, earn outs and the allocation of risks by the acquisition agreement. Relevant accounting, tax and antitrust issues and various regulatory considerations will also be covered. Prerequisites: Economics 174, and either Economics 372 or Economics 373. Instructor: Brown. 3 units.

514. Fixed Income Markets and Quantitative Methods. Areas of focus include: The value of money and discounted cash flow concepts, statistics, probability concepts, correlation & regression, understanding risks associated with bonds, and bonds with embedded options, and mortgages and the mortgage markets. Prerequisites: Economics 372. Instructor: Brown. 3 units.

515. Introduction to Law & Economics. 3 units. C-L: see Law 359

521. Evaluation of Public Expenditures. 3 units. C-L: see Public Policy Studies 596; also C-L: Environment 532

522S. Seminar in Applied Project Evaluation. 3 units. C-L: see Public Policy Studies 597S

523. Microfinance. Microfinancing, in which small loans are given to those who are impoverished/lack collateral, has been credited for alleviating poverty/raising the incomes of millions of people in developing countries. Is it really so successful? Course focuses on historical/theoretical basis of microfinance. Students engage in a critical assessment of microfinance. Overall, students gain factual/historical information concerning the "microfinance revolution", learn the basic theoretical/analytical tools needed to design microfinance programs, and engage in critical thinking regarding recent debates in the field. Graduate pairing for Econ 323; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

527. Regulation and Deregulation in Public Utilities. Class explores historical basis for regulation of public utilities from an economic/legal perspective. Application of standard monopoly microeconomics leading to rate of return regulation is developed. This background sets stage for evolution of economic thought on electric power system economics and changes in some states, to "deregulate," the electricity markets. Class will explore case studies of developments in these markets, including evolution of regional market clearing entities like PJM, the basis for location marginal pricing, measures of market power, and pricing of capacity/reliability. Graduate pairing for Econ 328; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

529S. Medical Malpractice. Seminar will focus on each of four medical malpractice "system" markets. Students will write a term paper on one aspect of one market. A book will be assigned and readings from journal articles. The
seminar will be of interest to anyone who wants to learn more about medical malpractice, tort, how legal markets and insurance operate, and the political economy of "tort reform." Graduate pairing for Econ 329S; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

530. Resource & Environmental Economics I. 1.5 units. C-L: see Energy 520; also C-L: Public Policy Studies 576

530D. Resource and Environmental Economics and Policy. 3 units. C-L: see Environment 520D; also C-L: Public Policy Studies 575D

530L. Resource and Environmental Economics. 3 units. C-L: see Environment 520L; also C-L: Public Policy Studies 575L

530S. Investment Strategies. Course examines issues in personal investment strategies. Read/discuss a number of books/articles. Topics include behavioral finance, mutual funds, data-mining, Islamic funds, junk bonds, inflation indexed bonds, life cycle investing, market timing, passive versus active investing, predicting performance, pumping performance, rebalancing, sector funds, stock market anomalies, survivorship bias, tax managed investing, time zone arbitrage, and Tobin's Q. Substantive research paper required as well as midterm and final exams. Graduate pairing for Econ 272S; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

531. Resource & Environmental Economics II. Variable credit. C-L: see Environment 521; also C-L: Public Policy Studies 584

541S. Global Inequality Research Seminar. 3 units. C-L: see African and African American Studies 642S; also C-L: Sociology 642S, Political Science 642S, Public Policy Studies 645S

542S. Social Change, Markets, and Economy in China. 3 units. C-L: see Sociology 651S

544S. Computer Modeling. Introduction to the use of computer techniques in economic policy evaluation; policy applications to international economics, public finance and development economics; computer analysis of linearized and nonlinear models using Excel and GAMS. Students required to complete a major modeling project. Graduate pairing for Econ 344S; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

547S. Economy, Society, and Morality in Eighteenth-Century Thought. 3 units. C-L: see Political Science 675S

548S. Political Economy of Growth, Stabilization and Distribution. 3 units. C-L: see Political Science 645S; also C-L: Public Policy Studies 630S

550S. Global Responses to the Rise of China. 3 units. C-L: see Sociology 650S


553. 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 433, but intended for MA students. Instructor: Staff. 3 units.

554. Urban Economics. Introduction to urban and spatial economics. Neoclassical monocentric city spatial model, patterns of land values, property prices, residential density and impact of distressed communities on broader development. Systems of cities and regional growth, role of cities in economic development. United States urban features: ethical and socio-economic effects of housing segregation and implications for discrimination. Tradeoffs between efficiency and fairness in housing resource allocation. Business location theory, impact of innovations in transportation, and technology's effect on work patterns. Same as Economics 345, but requires additional work. Not open to students who have taken Economics 345. Instructor: Staff. 3 units.

555S. International Trade. International trade, investment and migration, commercial policy, and the political economy of trade. Prerequisite: Economics 205D; and Economics 210D. Instructor: Staff. 3 units.
556. 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 institutions, economic roles of Islamic law, innovation and change, political economy of modernization, interactions with other regions, economic consequences of Islamism. This is the graduate only pairing for Econ 134 which requires additional course work. Instructor: Staff. 3 units.

557S. International Macroeconomics. Analysis of the determinants of international capital movements, trade imbalances, and 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 Economics 455 but with additional work. This course is not open to students who have taken Economics 455. Prerequisites: Economics 205D and 210D. Instructor: Staff. 3 units.

558. Islam and the State. Introduction to political history of Middle East. Four objectives: (1) become familiar with institutions responsible for political development in region, (2) examine transformations/cases of inertia to derive lessons about mechanisms that govern political development, including democratization, (3) investigate how religion shaped region’s political trajectory, (4) identify social forces, especially economic, driving contemporary reinter- pretation of Islam’s political organization and requirements, by both Islamists and secular political actors. Not open to students who have taken Economics 326. Graduate students only. Instructor consent required. Instructor: Staff. 3 units.

561. African Economic Development. Same as undergraduate course of the same name but requires an additional paper. This course will seek to provide students with a realistic picture of African economies and societies today, emphasizing their heterogeneity and accomplishments, as well as focusing on reasons for continued widespread poverty throughout the continent. The course develops behavioral models that can be used to explain and predict household, market, and government behaviors and outcomes. Students are expected to quickly acquire basic stylized facts and economic models, and then analyze one of the many data sets now available. Instructor: Staff. 3 units.

564. 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 telecommunication, retail and airlines. Similar to Economics 464, but requires additional assignment. Not open to students who have taken Economics 464. Instructor: Staff. 3 units.

567. Computer Modeling. Introduction to the use of computer techniques in economic policy evaluation; policy applications to international economics, public finance and development economics; computer analysis of linearized and nonlinear models using Excel and GAMS. Students required to complete a major modeling project. Prerequisites: Economics 205D and 210D. Instructor: Staff. 3 units.

567S. Computer Modeling. Introduction to the use of computer techniques in economic policy evaluation; policy applications to international economics, public finance and development economics; computer analysis of linearized and nonlinear models using Excel and GAMS. Students required to complete a major modeling project. Prerequisites: Economics 205D and 210D. Instructor: Staff. 3 units.

568S. Current Issues in International and Development Economics. Issues of income distribution within and between countries, vehicles for growth, regional development, the role of politics in economic policy, multinational institutions. Cross-country and cross-time comparisons. Emphasis on individual research projects. Prerequisite: Economics 205D and Economics 210D. Instructor: Staff. 3 units. C-L: International Comparative Studies 512S

570. International Finance. Analysis of the determinants of international capital movements, trade imbalances, and 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. Graduate pairing for Econ 455; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

571. Financial Markets and Investments. Same as Economics 471, but requires an additional paper. Prerequisite: Economics 205D; Economics 210D; and Statistical Science 101, 111, 230,130 or 250, or Mathematics 230 or 342. Instructor: Staff. 3 units.

572. Intermediate Finance. Integrates micro and macro economics with topics in finance. Utility maximization within mean variance framework for portfolio analysis and capital asset pricing model. Corporate valuation and
discounted cash flow analysis. Capital structure and principal-agent problem will lead into a discussion of the Efficient Markets Hypothesis and underlying assumptions. Market pricing, forecasting, and financial crises. Graduate pairing for Economics 372; graduate students will receive additional writing assignments. For graduate students only. Instructor: Staff. 3 units.

580. Law and Economics. A qualitative and quantitative introduction to economic analysis of legal issues and legal reasoning. Case studies in accident law, product liability, and the value of life. Other topics include contracts, property, affirmative action, civil procedure, and the economics of criminal behavior. Some models examined include a calculus-based approach. Graduate pairing for Econ 463; graduate students will receive additional writing assignments. Instructor: Staff. 3 units.

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

590S. Selected Topics in Economics. Seminar version of Economics 590. 3 units.

591. 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.

593. 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.

597. 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 318S, but requires an additional assignment. Not open to students who have taken Economics 318S) Prerequisites: Economics 205D; and Economics 210D or 248; and consent of instructor. Instructor: Staff. 3 units.


602. 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 601. Instructor: Staff. 3 units.

604. 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: Staff. 3 units.

605. Advanced Microeconomic Analysis. Topics include consumption, production, investment, uncertainty and information. Instructor: Becker or Graham. 3 units.

606. Advanced Macroeconomics II. This course will briefly introduce you to some of the most widely used core models of modern macroeconomics. At the same time it will provide a strong theoretical and practical background that can be helpful if pursuing further studies in (macro-)economics. In particular we will build, step-by-step, one of the standard workhorses to study the business cycles, the real business cycles (RBC) model. We will start from its ancestor, the Solow growth model, pass by its origins, the deterministic neoclassical growth model, and work all the way up to its current dynamic stochastic general equilibrium (DSGE) model version. Instructor: Staff. 3 units.

608D. Introduction to Econometrics. Data collection, estimation, and hypothesis testing. Use of econometric models for analysis and policy. (Same as Economics 208D but requires additional term paper; not open to students
who have taken Economics 208D.) Economics MA's only. All other students require permission number. Prerequisites: Economics 21 and 22 or 201D; Mathematics 212 (co-requisite); Statistical Science 101, 111, 230, 130 or 250, or Mathematics 230 or 342. Instructor: Staff. 3 units.

612. 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 208D) plus a course in Linear Algebra or consent of the instructor. A course in macroeconomics (Economics 210D) is very useful but not strictly enforced. Instructor: Staff. 3 units.

613. Applied Econometrics in Microeconomics. Empirical research in microeconomics, with emphasis on three main sub-fields: 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 Economics 411, but additional work required. Not open to students who have taken Economics 411. Prerequisite: Economics 208D or 608D. Instructor: Staff. 3 units.

656S. 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. Economics MA students only. Instructor: Staff. 3 units.

673. Mathematical Finance. 3 units. C-L: see Mathematics 581

674. Financial Derivatives. 3 units. C-L: see Mathematics 582

675. Corporate Finance Theory: Governance, Incentives and Valuation. Course uses tools of contract theory (information economics, mechanism design, and game theory) to analyze key features of corporate structure, performance, and valuation. Investigates critical interactions among stakeholders in a modern business enterprise (directors, executives, management, labor, financiers, shareholders, and regulators) in achieving goals and objectives of the corporation. Topics include: reform of corporate governance and auditing; role of private equity, financial markets, and takeovers; efficient determination of leverage, dividends, liquidity, and risk management, and design of managerial incentive packages. Prerequisite: Economics 205D. Instructor: Taylor. 3 units.

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

690-82. Topics in Mathematical Finance. 3 units. C-L: see Mathematics 690-82

690S. Selected Topics in Economics. Seminar version of Economics 690. Instructor: Staff. 3 units.

700. Mathematics for Economists. Topics include linear and matrix algebra, topology, multivariate calculus, optimization and dynamic systems. For Economics incoming PhD students only. Instructor: Staff. 3 units.

701. 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: Staff. 3 units.

701D. Microeconomic Analysis I. Same in content as Economics 701, but with weekly discussion section. Econ PhD students only. Instructor: Staff. 3 units.

702. 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: Staff. 3 units.

702D. Macroeconomic Analysis I. Same in content as Economics 702, but with weekly discussion section. Econ PhD students only. Instructors: Staff. 3 units.

703. 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 with consent of instructor. Instructor: Staff. 3 units.
703D. Econometrics I. Same in content as Economics 703, but with weekly discussion section. Econ PhD students only. Instructors: Staff. 3 units.

704. First 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.

705. Microeconomic Analysis II. An introduction to game theory and information economics with applications such as oligopoly, bargaining, auctions, and reputations. Prerequisite: Economics 701. Instructor: Staff. 3 units.

705D. Microeconomic Analysis II. Same in content as Economics 705, but with weekly discussion section. Prerequisites: Econ 701D. This course is only open to Econ PhD Students. Instructor: Staff. 3 units.

706D. Macroeconomic Analysis II. Same in content as Economics 706, but with weekly discussion section. Instructors: Staff. 3 units.

707. Econometrics II. Advanced multivariate regression analysis. Topics include panel data models, systems, limited dependent variables, discrete choice, and nonlinear estimation. Prerequisite: Economics 703. Instructor: Staff. 3 units.

707D. Econometrics II. Same in content as Economics 707, but with weekly discussion section. Prerequisites: Econ 703D. Open to Econ PhD Students only. Instructor: Staff. 3 units.

711. Real Analysis for Economists. Topics include metric spaces, continuity, convexity, fixed point theory and normed linear spaces. This course is for students who have completed the first year of the PhD program in Economics. Instructor: Staff. 3 units.

713. Vocational Skills for Econometrics. 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. This course is for students who have completed the first year of the PhD program in Economics. Instructor: Staff. 3 units.

751. The Political Economy of Institutions. Provides survey of institutional analysis, focusing on recent developments in economics, political science and legal studies. Emphasis is on analysis of institutional change and the functions of institutions. Explores mechanisms by which constitutions, laws, customs and conventions undergo transformations. Topics include pace of institutional transformation, latent change, social inertia, political revolutions, links between beliefs/behaviors, and the social functions of laws, customs and conventions. Readings and case studies reflect the interdisciplinary characteristic of field. Prerequisites: Econ 701D and 705D or Econ 601 and Econ 605 and must be Econ PhD or PolSci PhD or instructor consent. Instructor: Staff. 3 units. C-L: Political Science 762

752. Sustainability and Renewable Resource Economics. 3 units. C-L: see Environment 752

753. Natural Resource Economics. 3 units. C-L: see Environment 829

756. Health Economics: Supply. Semester-long survey course designed for students considering PhD research in health economics. Topics will include the economics of hospital care, physicians' services, pharmaceuticals and vaccines and long-term care, including nursing home care. Literature from general economics journals is emphasized. Studies are based on U.S. data and data from other countries at all levels of economic development. Instructors: Sloan and Mohanan. 3 units.

757. 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: Staff. 3 units.

790. Writing & Presenting in Economics. Writing and presenting are crucial for professional success, but often are not done effectively by economists. In part, this is because economics graduate students aren't explicitly taught how to write and present. This module is designed to fill this gap by teaching basic principles of communication for young economists. Over 3 intensive weeks, you will learn foundational principles of writing and presenting, and then
apply these concepts in brief but rigorous assignments that will require students to write and make presentations. Instructor: Staff. 1.5 units.

881. Special Topics in Applied Microeconomics. Prerequisites: Econ 301D (701D), 302D (705D), 320D (702D), 322D (706D), 341D (703D) and 342D (707D). Open to Econ PhD students only. Instructor: Staff. Variable credit.

882. Special Topics in Macro International Finance. Prerequisites: Econ 301D (701D), 302D (705D), 320D (702D), 322D (706D), 341D (703D) and 342D (707D). Open to Econ PhD students only. Instructor: Staff. Variable credit.

883. Special Topics in Econometrics. Prerequisites: Econ 301D (701D), 302D (705D), 320D (702D), 322D (706D), 341D (703D) and 342D (707D). Open to Econ PhD students only. Instructor: Staff. Variable credit.

885. Special Topics in Economic Theory. Prerequisites: Econ 301D (701D), 302D (705D), 320D (702D), 322D (706D), 341D (703D) and 342D (707D). Open to Econ PhD students only. Instructor: Staff. Variable credit.

887. Special Topics in Financial Econometrics. Prerequisites: Econ 701D, 705D, 702D, 706D, 703D and 707D. Open to Econ PhD students only. Open to Econ PhD students only. Instructor: Staff. Variable credit.

890. Special Topics in Economics. Prerequisites: Econ 701D, 702D, 703D, 705D, 706D, 707D. Only open to Econ PhD Students. Instructor: Staff. Variable credit.

890S. Special Topics in Economics. Prerequisites: Econ 701D, 702D, 703D, 705D, 706D, 707D. Only open to Econ PhD Students. Instructor: Staff. 3 units.

898. Directed Research. Consent of the director of graduate studies and instructor required. Instructor: Staff. Variable credit.

901. 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 PhD 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. Open to PhD Students Only. Instructor: Staff. 3 units.

902. 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 PhD 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. Pre-req: Students are required to have completed Econ 701D, 702D, 703D, 705D, 706D, and 707D. Open to Econ PhD students only Instructor: Staff. 3 units.

903. 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. Pre-req: Students are required to have completed Econ 701D, 702D, 703D, 705D, 706D, and 707D. Open to Econ Ph.D. students only Instructor: staff. 3 units.

905. 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.

908. 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.

909. Economic Thought and History of Political Economy Workshop. Discuss and analyze in detail recent papers drawn from literature relevant to Economic Thought/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.
951S. **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: Economics 901, 902, 903, 905, 908, or 909 concurrently. Instructor: Staff. 1.5 units.

952S. **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 901, 902, 903, 905, 908, or 909 concurrently. Instructor: Staff. 1.5 units.

953S. **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 encourages to present early version of own research. Prerequisite: Economics 901, 902, 903, 905, 908, or 909 concurrently. Instructor: Staff. 1.5 units.

955S. **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 901, 902, 903, 905, 908, or 909 concurrently. Instructor: Staff. 1.5 units.

957S. **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, Economics 901, 902, 903, 905, 908, or 909 concurrently. Instructor: Staff. 1.5 units.

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**Economics and Computation**

Professor Donald Rose, *Master's Program Director for Economics and Computer Science* (N302 North); Research Professor Charles Becker, *Master's Program Director for Economics and Computation and Associate Chair of Economics* (312 Social Sciences).

*Faculty in Computer Science:* Professors Pankaj Agarwal, Owen Astrachan, Shivnath Babu, Theo Benson, Robert Calderbank, Jeffrey Chase, Vincent Conitzer, Landon Cox, Bruce Donald, Robert Duvall, Jeffrey Forbes, Alexander Hartemink, Alvin Lebeck, Richard Lucic, Ashwin Machanavajjhala, Bruce Maggs, Kamesh Munagala, Debmalya Panigrahi, Ronald Parr, John Reif, Susan Rodger, Xiaobai Sun, Carlo Tomasi, Jun Yang, Xiaowei Yang.


The master's program in economics and computation is a joint program between the departments of computer science and economics. Students preparing to enter this program will find an undergraduate background in mathematics, engineering, computer science, statistics, or economics to be helpful. It is designed to train and develop computational skills linked to economics, finance, policy, and related areas to prepare graduates for PhD studies or related professions. Students complete coursework in both computer science and economics. Graduates will be awarded an MS in economics and computation as their degree.

Students must complete a minimum of 30 course credits: 12 course credits in computer science courses numbering 500 or above, or substitutes approved by the master's program director for computer science, 12 course credits in select economics courses (Economics 601, 602, 605, 606, 608D, 612, 613, 552, 690, 701, 702, 703, 705,
706, 707, 713, or approved substitutes, with no more than 6 course credits from any one of the subfields of microeconomics, macroeconomics, and econometrics), and 6 course credits for the independent research paper guided by faculty members from the Department of Computer Science and/or Economics. Remedial or preparatory courses may also be required, including EIS courses as mandated, Mathematics 216 (Linear Algebra/Differential Equations), Mathematics 431 (Advanced Calculus), and Economics/Computer Science 690 (Numerical Methods).

Students must pass a final exam administered by their committee covering a portfolio of learning and research activities carried out during their master's studies. The portfolio must include one of the following two items: a capstone course in either computer science or economics, or a written master's thesis or project report on an approved topic developed via independent study with one or more computer science and/or economics faculty advisors if available. This document is expected to describe a mature project with research content.

**Computer Science Courses (COMPSCI)**

- 510. Operating Systems. 3 units.
- 512. Distributed Information Systems. 3 units.
- 514. Computer Networks and Distributed Systems. 3 units.
- 515. Wireless Networking and Mobile Computing. 3 units.
- 520. Numerical Analysis. 3 units.
- 524. Nonlinear Dynamics. 3 units.
- 527. Introduction to Computer Vision. 3 units.
- 528. Introduction to Computational Science. 3 units.
- 532. Design and Analysis of Algorithms. 3 units.
- 534. Computational Complexity. 3 units.
- 553. Compiler Construction. 3 units.
- 554. Fault-Tolerant and Testable Computer Systems. 3 units.
- 555. Probability for Electrical and Computer Engineers. 3 units.
- 561. Computational Sequence Biology. 3 units.
- 570. Artificial Intelligence. 3 units.
- 571. Machine Learning. 3 units.
- 579. Statistical Data Mining. 3 units.
- 590. Advanced Topics in Computer Science. 3 units.
- 624. Nanoscale and Molecular Scale Computing. 3 units.
- 632. Approximation Algorithms. 3 units.
- 634. Geometric Algorithms. 3 units.
- 636. Computational Topology. 3 units.
- 662. Computational Systems Biology. 3 units.
- 663. Algorithms in Structural Biology and Biophysics. 3 units.
- 664. Computational Structural Biology. 3 units.
- 673S. Computer Models and the Treatment of Psychiatric Disorders. 3 units.
- 710. Topics in Operating Systems. 3 units.
- 724. Advanced Topics in Nonlinear and Complex Systems. 3 units.
- 734. Theory of Computation. 3 units.
- 770S. Seminar in Artificial Intelligence. 3 units.
- 776. Advanced Topics in Artificial Intelligence. 3 units.

**Economics Courses (ECON)**

- 601. Microeconomics. 3 units.
- 602. Macroeconomic Theory. 3 units.
- 606. Advanced Macroeconomics II. 3 units.
- 608D. Introduction to Econometrics. 3 units.
- 612. Time Series Econometrics. 3 units.
- 613. Applied Econometrics in Microeconomics. 3 units.
- 552. Economic Growth. 3 units.
- 701. Microeconomic Analysis I. 3 units.
- 705. Microeconomic Analysis II. 3 units.
- 702. Macroeconomic Analysis I. 3 units.
- 706. Macroeconomic Analysis II. 3 units.
- 703. Econometrics I. 3 units.
- 707. Econometrics II. 3 units.
Engineering
Professor Katsouleas, Dean (305 Teer Engineering Library Building); Professor Reichert, Associate Dean for Graduate Education (1389 Fitzpatrick Center)

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 course credits of earned graduate credit beyond the bachelor's degree is required for the MS degree: twelve in the major, six in related minor work (usually mathematics or natural science), six in either the major or minor subject or in other areas approved by the major department, and six for a research-based thesis. A nonthesis option requiring 30 course credits 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 course credits of approved coursework are required in core courses, and 21 course credits in related areas; in electrical engineering, 24 course credits units are required in the major field and 12 course credits in a related minor field (often mathematics or natural science), 12 course credits in either the major or minor subject or other areas approved by the major department, and 12 course credits 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 http://www.pratt.duke.edu/.

Biomedical Engineering
Professor Henriquez, Chair; Professor Wax, Director of Graduate Studies; and Professor Yuan, Director of Masters Studies; Professors Barr, A. Brown, Chilkoti, Dewhirst, Erickson, Grill, Guilkak, Henriquez, Izatt, Johnson, Katz, Leong, Lopez, Masszalek, Myers, Neu, Nicolelis, Ramanujam, Reichert, Samei, Sapiro, Setton, Smith, Song, Stamer, Toth, Trahey, Truskey, Vo-Dinh, von Ramm, Warren, West, Yuan, Zalutsky, and Zauscher; Associate Professors Badea, Bursac, Dobbins, Idriss, Klitzman, Lo, MacFall, K. Nightingale, Sommer, Tornai, Wax, Wolf and You; Assistant Professors, DeFrates, Driehuys, Farsiu, Gersbach, Hoffman, and Petrechev; Professors Emeriti H. Clark, Friedman, McElhaney, and Plonsey; Associate Research Professors Bass and R. Nightingale

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, biotechnology, data acquisition and processing, medical imaging, and electrophysiology. Every biomedical engineering PhD student is required to serve as a teaching assistant as part of their graduate training.

Courses in Biomedical Engineering (BME)
502. 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 354L. Instructor: Wolf. 3 units. C-L: Neuroscience 502

503. 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: Biomedical Engineering 301L or equivalent. Instructor: Henriquez. 3 units. C-L: Neuroscience 503

504. 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. C-L: Neuroscience 504

506. Measurement and Control of Cardiac Electrical Events (GE, EL, IM). 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 301L; 354L or instructor consent. Instructor: Wolf. 3 units. 510. Bayesian Analysis in Biomedical Engineering (GE, EL). The application of Bayesian statistics to questions in BME broadly with a focus on electrocardiography. Topics include a brief history of Bayesian math in biology and medicine, use of likelihood functions and prior distributions, the Bayesian outlook toward medical diagnosis, the work of Cornfield, Pipberger, and Dunn on the classification of electrocardiograms, and a Bayesian framework for the cardiac inverse problem. The approaches used for these topics can be adapted to many other BME situations. Prerequisites: Senior or graduate standing. Instructor: Barr. 3 units.

511L. Intermediate Bioelectricity (GE, EL). Study of the origins of clinically-relevant electrical signals, such as EEG, ECG, or EMG. Generation of biopotentials by active cells, fibers, and tissues. Transmission of biopotentials to the measuring electrodes through intervening tissues; effects of inhomogeneities and anisotropy. Students develop models of biopotentials and learn numerical and mathematical tools for solving and analyzing these models. Laboratory exercises based on computer simulations, with emphasis on quantitative behavior. Readings from original literature. Prerequisite: BME 301L or consent of the instructor. Instructor: Barr, Henriquez, or Neu. 4 units. C-L: Neuroscience 511L

512L. Cardiac Bioelectricity (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 301L or equivalent. Instructor: Barr or Henriquez. 4 units.

515. Neural Prosthetic Systems (GE,EL,IM). Covers several systems that use electrical stimulation or recording of the nervous system to restore function following disease or injury. For each system, the underlying biophysical basis for the treatment, the technology underlying the treatment, and the associated clinical applications and challenges are examined. Systems to be covered include cochlear implants, spinal cord stimulation of pain, vagus nerve stimulation for epilepsy, deep brain stimulation for movement disorders, sacral root stimulation for bladder dysfunction, and neuromuscular electrical stimulation for restoration of movement. Prerequisites: BME 301L; BME 253L or ECE 110L or equivalent; consent of the instructor. Instructor: Grill. 3 units. C-L: Neuroscience 515

517. Neuronal Control of Movement (GE, EL). Course for graduate and upper-level undergraduate students to provide them with an understanding of the neuronal circuits that move our bodies and with techniques for analysis, simulation, and modification of these circuits by neural engineers. Topics start in the periphery with muscles, the spine, and functional electrical stimulation; then proceed centrally to subcortical circuits, deep brain stimulation, and forward models; and conclude with cerebral cortical networks and population decoding. Students are expected to have background in bioelectricity and Matlab programming. Prerequisites: BME 301L or consent of the instructor. Instructor: Sommer. 3 units. C-L: Neuroscience 507
522L. Introduction to Bionanotechnology Engineering (GE, BB, MC). 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 302L or consent of the instructor. Instructor: Staff. 3 units.

523. Biomedical Polymers (GE, BB, MC). Course covers applications of polymers in medicine, particularly drug delivery, gene delivery, and tissue engineering. Most recent advances in the field will be discussed. Students' critical understanding of the concepts covered in the class will be evaluated through written and oral presentations. This course is primarily intended for seniors and graduate students. Prerequisites: BME 302L; graduate students need consent of the instructor. Instructor: Leong. 3 units.

524. Nanotechnology in Medicine (GE, BB, MC). Nanomedicine impacts biomedical sciences by applying nanotechnology to develop devices with nanoscale features for applications in therapeutics, diagnostics, and molecular tools. The course covers the application of nanotechnology to advance drug therapy, gene therapy, immunotherapy, and cell therapy and discusses engineering design and fabrication strategies for practical implementation. Most recent advances in the field will be discussed. Student's critical understanding will be evaluated through written or oral presentations. Prerequisites: BME 302L or BME 307 or permission of the instructor. Instructor: Leong. 3 units.

525. 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. Prerequisites: ME 221L or graduate standing in BME or ME; BME 302L recommended. Instructor: Reichert. 3 units. C-L: Mechanical Engineering and Materials Science 518

526. Elasticity (GE, BB). 3 units. C-L: see Civil and Environmental Engineering 521

527. Cell Mechanics and Mechanotransduction (GE, BB, MC). An examination of 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 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 critically evaluate current literature and analyze models of cell mechanics and mechanotransduction. Prerequisites: BME 302L or BME 307; knowledge of cell biology. Instructor: Hoffman or Truskey. 3 units.

528. Biofluid Mechanics (GE, BB, MC). 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: BME 302L or BME 307. Instructor: Katz. 3 units.

529. Theoretical and Applied Polymer Science (GE, BB). 3 units. C-L: see Mechanical Engineering and Materials Science 514

530. Introduction to Tissue Biomechanics (GE, BB). Introduction to the mechanical behaviors of biological tissues, cells and molecules of the musculoskeletal and cardiovascular systems. Topics to be covered include static force analysis and nonlinear optimization theory; linearly elastic models for stress-strain analysis and solutions to relevant problems in bioelasticity; models of active structures (e.g., muscles); and introductory theory for finite element analysis. Emphasis will be placed on modeling stress-strain relations with relevance to biological tissues, including experimental means to measure stress and strain in these structures. Prerequisites: Engineering 201 or equivalent; Biomedical Engineering 302 or equivalent; Mathematics 353. Instructor: Setton. 3 units.

531. 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: Engineering 201L; Mathematics 353. Instructor: Myers or Setton. 3 units.

542. 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: Biomedical Engineering 303; Engineering 103L; or instructor consent. Instructor: K. Nightingale or von Ramm. 3 units.

545. Acoustics and Hearing (GE, EL, 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 271 or equivalent; Mathematics 353. Instructor: Collins or Trahey. 3 units. C-L: Electrical and Computer Engineering 584

551L. Biomedical Optical Spectroscopy and Tissue Optics (GE, IM). This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the application of optical spectroscopy and tissue optics in biological and biomedical engineering. Topics covered in this course include: Absorption Spectroscopy; Scattering Spectroscopy; Fluorescence Spectroscopy; Tissue Optics; Monte Carlo Modeling; Diffusion Modeling; Spectroscopic System Design and Signal to Noise Analysis; and Molecular Imaging. This course also includes labs for each topic that is covered, journal article review on emerging technologies and a term project. Prerequisite: Physics 152L. Instructors: Izatt, Ramanujam or Wax. 4 units.

552. Advanced Optics. 3 units. C-L: see Physics 621; also C-L: Electrical and Computer Engineering 541

560. Molecular Basis of Membrane Transport (GE, EL, MC). 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 201L or instructor consent, Mathematics 216 or equivalent. Instructor: Neu. 3 units. C-L: Neuroscience 560

561L. Genome Science and 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 biochemistry is required. Instructor consent required. Instructor: Satterwhite. 3 units. C-L: Computational Biology and Bioinformatics 561L

562. Biology by Design (GE, MC). This course is an introduction to engineering biological systems with an emphasis on synthetic biology and the application of biological and chemical principles to the design of new biomolecules and cellular pathways. It is taught from the primary scientific literature and highlights contemporary research in this area, including topics such as artificial amino and nucleic acids, gene regulatory systems, directed molecular evolution, recombinant antibodies, novel biosynthesis pathways, cell communication, and the design of minimal organisms. These topics are presented in the context of applications such as drug design, discovery, productions, regenerative medicine, and bioremediation. Prerequisite: Biology 201L. Organic chemistry and/or biochemistry courses are suggested. Instructor: Gersbach. 3 units.

563. Transport Processes in HIV Transmission and Prevention (GE, BB, MC). Application of transport theory to analyze processes of HIV migration to target cells in the mucosa of the lower female reproductive tract. Analysis of the introduction, transport and bioactivity of molecules that inhibit these HIV-infection processes, including those acting topically (microbicides) and those introduced in a variety of drug delivery vehicles: semi-solid materials (gels, films) and solid materials (intravaginal rings). A succession of mathematical models will describe elements of the
fundamental biology of this system and analyze the performance of specific products that act prophylactically against HIV infection. Prerequisite: BME 307 or instructor consent. Instructor: Katz. 3 units.

565L. Environmental Molecular Biotechnology (GE, MC). 3 units. C-L: see Civil and Environmental Engineering 661L.

566. 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 307 or equivalent. Instructor: Truskey or Yuan. 3 units.

567. Biosensors (GE, IM, MC). Theory and applications of biosensors. Basic principles of interactions between analytes and bioreceptors and various transduction techniques: optical, electrochemical, ion-selective electrode-based, voltammetric, conductometric, and mass-sensitive techniques as well as novel nanotechnology-based biosensing systems including nanosensors, plasmonic nanoprobes, quantum dots, carbon nanotubes, molecular beacons, and molecular sentinel systems. Applications in chemical, environmental, biological and medical sensing. Paired with Chemistry 601. Prerequisites: senior or graduate standing in BME or instructor's consent. Instructor: Vo-Dinh. 3 units.

568. 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 307 or equivalent. Instructor: Truskey. 3 units.

569. 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 307 and consent of instructor. Instructor: Katz. 3 units.

570L. Introduction to Biomolecular Engineering (GE, BB, MC). Techniques of molecular biology through linked lectures and laboratory exercises with emphasis on molecular tools to manipulate and analyze DNA and RNA for specific molecular bioengineering applications. Lectures cover the genetic code, replication, transcription, translation, cloning vectors for E. coli, enzymatic manipulation of DNA, gene cloning, synthetic gene design and assembly, DNA sequencing, polymerase chain reaction, site-directed mutagenesis, overexpression and purification of recombinant proteins. Laboratory exercises, linked to lectures, cover cloning, mutagenesis and recombinant protein expression and purification. Prerequisites: BIO 201L or BME 260L or graduate standing in BME. Instructor: Chilkoti. 3 units.

571L. Biotechnology and Bioprocess Engineering (GE, BB, MC). Introduction to the engineering principles of bioprocess engineering. Topics include: introduction to cellular and protein structure and function; modeling of enzyme kinetics, DNA transcription, metabolic pathways, cell and microbial growth and product formation; bioprocess operation, scale-up, and design. Class includes a design project. A modern biotechnology process or product is identified, the specific application and market are described (for example, medical, environmental, agricultural) along with the engineering elements of the technology. Prerequisite: Mechanical Engineering 221L. Instructor: Chilkoti or Reichert. 3 units.

574. Modeling and Engineering Gene Circuits (GE, MC). 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 infor-
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 260L or consent of instructor. Instructor: You. 3 units. C-L: Computational Biology and Bioinformatics 574

577. Drug Transport Analysis (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. Prerequisites: Biomedical Engineering 307; Engineering 103L; or consent of the instructor. Instructor: Yuan. 3 units.

578. Quantitative Cell and Tissue Engineering (GE, BB, 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: BME 302L or BME 307 or consent of the instructor. Instructor: Bursac. 3 units.

590. Special Topics in Biomedical Engineering. Special subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required. Instructor: Staff. 3 units.

590L. Special Topics with Lab. To be used as a "generic" course number for any special topics course with lab sections. Instructor: Staff. 3 units.

609. Optics and Photonics Seminar Series. 3 units. C-L: see Electrical and Computer Engineering 549; also C-L: Physics 549

690. 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.

702S. 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.

711S. Biological Engineering Seminar Series (CBIMMS and CBTE). 1 unit. C-L: see Mechanical Engineering and Materials Science 717S

712S. Biological Engineering Seminar Series (CBIMMS and CBTE). 1 unit. C-L: see Mechanical Engineering and Materials Science 718S

717S. 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.

733. Experimental Design and Biostatistics for Basic Biomedical Scientists. 2 units. C-L: see Pharmacology and Cancer Biology 733; also C-L: Neurobiology 733, Cell and Molecular Biology 733

740L. Fundamentals of Bioelectric Engineering. The electrophysiology of excitable cells from a quantitative perspective. Topics include ionic basis of action potentials, Hodgkin-Huxley model, impulse propagation, extracellular measurements, and introduction to functional electrical stimulation. Labs include stimulation and recording of nerve and heart potentials, optical imaging of excitation waves, and numerical modeling. In a final project, students design and perform their own experiments based on the classical literature and the skills they learned in the course. Not open to students who have taken BME 301L or equivalent. Prerequisites: recommended a circuits course and
knowledge of ordinary and partial differential equations. Instructor: Henriquez, Neu, Sommer. 4 units. C-L: Neuroscience 740L

770. Transport Phenomena in Biological Systems. Consideration of the role of transport processes and the understanding and modeling of biological systems. 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. Biological and biotechnological applications are presented. Prerequisites: Introductory coursework in fluid mechanics and in mass transport theory. Experience with solving ordinary and partial differential equations. Instructor: Katz, Truskey, or Yuan. 3 units.

785. 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.

787. 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.

788. 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. 3 units.

789. Internship in Biomedical Engineering. 375. Internship. Student gains practical biomedical 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. Variable credit.

790. 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.

790L. Advanced Topics with the Lab 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. Includes laboratory component. Instructor: Staff. 3 units.

791. Graduate Independent Study. First Independent Study course in advanced study and research areas of biomedical engineering. Approval of adviser is required. 3 units. Instructor: Staff. 3 units.

792. Graduate Independent Study. Second Independent Study in advanced study and research areas of biomedical engineering. Approval of adviser is required. 3 units. Instructor: Staff. 3 units.

830. 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 (for example, cortical and trabecular bone), soft tissues (for example, ligament, cartilage, cornea, intervertebral disc, left ventricle, aorta), and biological fluids (for example, mucus, synovial fluid, polymer solutions). Tensor fields and indicial notation. Prerequisites: Biomedical Engineering 110L or Engineering 201L or equivalent, and Mathematics 111 or equivalent. Instructor: Setton. 3 units.
832. 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.

834. Viscoelasticity. Viscoelasticity of hard and soft tissue solids and composite structures. Linear and nonlinear one-dimensional viscoelastic behavior, internal damping, and three-dimensional viscoelasticity. Approximation techniques for determination of viscoelastic constitutive equations from experimental data. Mathematical formulations for the characterization of the dynamic behavior of biologic structures. Consent of instructor required. Instructor: Myers. 3 units.

836. 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 730 or consent of instructor. Instructor: Setton. 3 units.

842. 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 photoacoustic materials. Consent of instructor required. Instructor: S. Smith. 3 units.

844. 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 333. Instructor: Trahey. 3 units.

846. 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.

848L. Radiology in Practice. Designed to complement Biomedical Engineering 333 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: Biomedical Engineering 333 or equivalent. Instructor: Trahey. 3 units. C-L: Medical Physics 738

850. Advances in Photonics: An Overview of State-of-the-Art Techniques and Applications. The main goal of this course is to provide an 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 630

899. 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; Professors Albertson, Barros, Deshusses, Dolbow, Hueckel, Laursen, Petrofski, Porporato, Scovazzi, Virgin, Wiesner; Associate Professors Aquino, Boadu, Ferguson, Gavins, Gunsch, Hsu-Kim, Kabala, Peirce; Associate Professors of the Practice Nadeau and Schaad; Adjunct Associate Professor Linden; Adjunct Assistant Professor Khlystov, Scruggs, Schuler; Lecturer Brasier; Secondary Appointments: Professors Di Giulio (environmental toxicology), Doyle (river science and policy), Golden (sustainable systems analysis), Hench (oceanography), Hinton (environmental quality), Hunt (microbial ecology), Jeuland Public Policy) Kasibhatla (atmospheric chemistry), Knio (computational fluid mechanics), Kumar (watershed hydrology), Li (climate), Katul (hydrology), Mann (structural engineering), Marani (ecohydrology), Meyer (environmental toxicology), Oren (global change ecology), Richardson (wetland ecology), Stapleton (environmental chemistry), Vallero (engineering ethics); Vengosh (geochemistry), Virgin, (structural); Adjunct: Avissar, Bottero, Germano, Khystov, Linden, Laloui, Malin, McKinney, Miller, Rose, Scruggs, Schuler, Professors Emeriti, Medina and Wilson.

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.

Courses in Civil and Environmental Engineering (CEE)

501. 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: Mathematics 353 or equivalent and undergraduate courses in solid and/or fluid mechanics. Instructor: Kabala. 3 units.


511. Construction Management. This course is a broad overview of the roles and responsibilities of the construction management engineer. Included in this is an examination of: Project Management Planning, Cost Management, Time Management, Quality Management, Contract Administration, and Safety Management. Topics covered will include: defining the responsibilities and management structure of the project management team, organizing and leading by implementing project controls, defining roles and responsibilities and developing communication protocols, and identifying elements of project design and construction likely to give rise to disputes and claims. Field trips. Instructor: Schaad. 3 units.


521. 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 problems in civil and biomedical engineering will be discussed. Prerequisites: Engineering 201L; Mathematics 353. Instructor: Staff. 3 units. C-L: Biomedical Engineering 526

525. 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 353 or consent of instructor. Instructor: Boadu. 3 units.

530. 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: Aquino, Dolbow, Laursen, or Scovazzi. 3 units. C-L: Mechanical Engineering and Materials Science 524

535. 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.

541. 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.

560. 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.

561L. 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. Instructor: Hsu-Kim. 3 units. C-L: Environment 542L

562. 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.

563. Chemical Fate of Organic Compounds. 3 units. C-L: see Environment 540

564. 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.

565. Environmental Analytical Chemistry. This course covers the fundamentals and applications of analytical chemistry as applied to detection, identification, and quantification of anthropogenic contaminants in environmental samples including air, water, soil, sediment, and biota. The topics include both sample preparation methods (i.e. wet
chemistry) and instrumental analysis (e.g. mass spectrometry, chromatography, and optical spectroscopy). Particular emphasis is placed on current advancements in measurement science as applied to environmental chemistry. The material includes both theoretical and practical aspects of environmental analysis. Prerequisite: CHEM 131 or CHEM 151L or consent of instructor. Instructor: Ferguson. 3 units. C-L: Environment 566

566. 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: Civil and Environmental Engineering 462L or graduate standing or consent of the instructor. Instructor: Gunsch. 3 units.

569. 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: Staff. 3 units.


574. Remote Sensing in Coastal Environments. 3 units. C-L: see Earth and Ocean Sciences 530; also C-L: Environment 530

575. 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.

576L. 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: Staff. 3 units.

581. 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. Prerequisite: Civil and Environmental Engineering 301L and Mathematics 353, or equivalents. Instructor: Staff. 3 units.

585. 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 and Environmental Engineering 301L and Mathematics 353, or consent of instructor. Instructor: Kabala. 3 units.


623. 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 and Environmental Engineering 520 or consent of instructor. Instructor: Nadeau. 3 units.

625. Intermediate Dynamics: Dynamics of Very High Dimensional Systems. 3 units. C-L: see Mechanical Engineering and Materials Science 541

626. 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 244L and Mathematics 353 or consent of instructor. Instructor: Franzoni. 3 units. C-L: Mechanical Engineering and Materials Science 543

627. 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: Electrical and Computer Engineering 382 or Mechanical Engineering 344, or consent of instructor. Instructor: Staff. 3 units. C-L: Mechanical Engineering and Materials Science 627


629. System Identification. Numerical linear algebra for modeling and filtering data (FFT, SVD, QR, and PCA); ordinary least squares, total least squares, and recursive least squares; measurement noise and propagation of measurement error; regularization; optimal linear filtering; state-space models, eigensystem realization, deterministic and stochastic subspace identification through projections and canonical correlation. Applications drawn from engineering, natural sciences, and finance. Instructor: Gavin. 3 units.

630. 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: Civil and Environmental Engineering 530/Mechanical Engineering 524, or consent of instructor. Instructors: Aquino, Dolbow, Laursen, or Scovazzi. 3 units. C-L: Mechanical Engineering and Materials Science 525

635. 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: Civil and Environmental Engineering 530, or 630, or instructor consent. Instructor: Dolbow. 3 units.

641. Advanced Soil Mechanics. Characterization of behavior of geomaterials. Stress-strain incremental laws. Nonlinear elasticity, hypo-elasticity, plasticity and visco-plasticity 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 and Environmental Engineering 302L or equivalent. Instructor: Hueckel. 3 units.
642. **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.

643. **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, and ground penetrating radar technology. Prerequisite: Mathematics 353 or Physics 152L, or consent of instructor. Instructor: Boadu. 3 units.


645. **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.

646. **Plates and Shells.** Differential equation and extremum formulations of linear equilibrium problems of Kirchhoffian and non-Kirchhoffian plates of isotropic and anisotropic material. Solution methods. Differential equation formulation of thin anisotropic 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: (Civil and Environmental Engineering 421L or Mechanical Engineering 321L) and Mathematics 353. Instructor: Virgin. 3 units. C-L: Mechanical Engineering and Materials Science 626

647. **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 and Environmental Engineering 421L, or consent of instructor. Instructor: Virgin. 3 units. C-L: Mechanical Engineering and Materials Science 527


649. **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 Civil and Environmental Engineering 429, 469, or 679. Consent of instructor required. Instructor: Nadeau. 3 units.

661L. **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: Civil and Environmental Engineering 462L, Biology 20, Biology 201L, or graduate standing, or consent of instructor. Instructor: Gunsch. 3 units. C-L: Biomedical Engineering 565L

662. **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 encoun-
tered 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 and Environmental Engineering 301L and Mathematics 353, or consent of instructor. Instructor: Kabala. 3 units.

665. Our Changing Atmosphere: From Air Pollution to Climate Change. 3 units. C-L: see Environment 739

666. Aquatic Geochemistry. Geochemistry of the water-solid interface of soils, minerals, and particles in earth systems. Topics will cover the chemical composition of soils, geochemical speciation, mineral weathering and stability, sorption and ion exchange, soil redox processes, and chemical kinetics at environmental surfaces. Prerequisites: CE/ENVIRON 561L or CEE 461L or EOS 525 or ENVIRON 360 or permission of instructor. Instructor: Hsu-Kim. 3 units. C-L: Environment 666

667. Chemical Transformation of Environmental Contaminants. Mechanisms and principles underlying organic contaminant transformations in the ambient environment. Topics include hydrolysis, oxidation/reduction, direct and indirect photolysis, and reactions with disinfectant chemicals. Reactions will be considered in context of both natural (e.g. surface water and cloudwater) and engineered (e.g. drinking water, wastewater, and groundwater remediation) systems. Approaches will include both qualitative (reaction mechanism and product identification) as well as quantitative (reaction kinetics and stoichiometry) aspects of environmental reaction chemistry. Prerequisites: CEE 563/ENVIRON 540 or one semester of organic chemistry. Instructor: Ferguson. 3 units.

671. 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 and Environmental Engineering 462L. Instructor: Kabala. 3 units.

672. 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 and Environmental Engineering 462L, or consent of instructor. Instructor: Staff. 3 units. C-L: Environment 548

675. 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: Barros. 3 units.

676. 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 containments, advanced oxidation processes, mathematical modeling and design of UV systems. Includes laboratory exercises. Prerequisites: Civil and Environmental Engineering 564, or consent of instructor. Instructor: Staff. 3 units.

679. 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 Civil and Environmental Engineering 429, 469, or 649. Instructor: Schaad. 3 units.

681. 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. Prerequisite: Mathematics 353 and (Civil and Environmental Engineering 301L or 463L), or consent of instructor. Instructor: Kabala. 3 units.
682. 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 and Environmental Engineering 301L, or consent of instructor. Instructor: Staff. 3 units.


684. Physical Hydrology and Hydrometeorology. The objective of this course is to introduce and familiarize graduate students with the fundamental physical processes in Hydrology and Hydrometeorology that control and modulate the pathways and transformations of water in the environment. The content of the course will be strongly oriented toward providing students with a specific basis for quantitative analysis of the terrestrial water cycle including land-atmosphere interactions and clouds and precipitation (rain and snow) processes. The course should be of interest to undergraduate and graduate students interested in Environmental Science and Engineering, and Atmospheric and Earth Sciences. Instructor: Barros. 3 units.

685. 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 and Environmental Engineering 462L, or consent of instructor. Instructor: Staff. 3 units.

686. 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. Instructor: Porporato. 3 units.

687. Hydrologic Modeling for Water Quantity and Quality Assessment. 3 units. C-L: see Environment 769

690. 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.


761. Hydrologic and Environmental Data Analysis. 3 units. C-L: see Earth and Ocean Sciences 722; also C-L: Environment 722

780. 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.

890. 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.
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 four areas of specialization: computer engineering; information physics; microelectronics, photonics, and nanotechnology; signal and information processing. Detailed descriptions of course offerings, faculty research interests, and degree requirements may be found on the department’s website at [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 School of Medicine. 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 or the Center for Metamaterials and Integrated Plasmonics). Recommended prerequisites for graduate study in electrical engineering include knowledge of basic mathematics, statistics, and physics, electrical networks, electromagnetics, and system theory. Students with nonelectrical 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 at least two areas outside their area of specialization. There is no foreign language requirement.

### Courses in Electrical and Computer Engineering (ECE)

**511. Foundations of Nanoscale Science and Technology.** 3 units. C-L: see Nanosciences 511

**521. 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 216 or equivalent. Instructor: Brady, Brown, or Stiff-Roberts. 3 units.

**522. 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: Electrical and Computer Engineering 230L or Mechanical Engineering 344L or equivalent. Instructor: Kim. 3 units.

**523. 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: Electrical and Computer Engineering 521 or Physics 464 or equivalent. Instructor: Kim. 3 units. C-L: Physics 627

**524. 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 superconstru...
ductivity, with emphasis on understanding electrical and optical properties of solids. Prerequisite: quantum physics at the level of Physics 264L or Electrical and Computer Engineering 521. Instructor: Teitsworth. 3 units.

525. 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 530 or consent of instructor. Instructor: Staff. 3 units.


527. 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 and Computer Engineering 526. Instructor: Staff. 3 units.

528. 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 330 or 331L. Instructor: Fair. 3 units.


533. Biochip Engineering. A problem-solving course in which students consider technology options for a complete lab-on-a-chip design. Lectures cover the basics of analog flow microfluidic devices, digital microfluidic devices, fabrication technologies for discrete devices, system integration issues, and a significant emphasis on biological applications for analysis, sample preparation, and detection issues. Technologies covered will include microfluidic devices, electrophoresis, analytical methods used in genetics, sample preparation methods, and analyte detection. Prerequisites: Biology 201L, Chem 101DL, and Physics 152L (or equivalents). Instructor: Fair. 3 units.

534. 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 equipment, test generation, fault simulation, and built-in-self-test, and automated circuit synthesis including architecture generation, circuit synthesis, tuck 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: Electrical and Computer Engineering 331L. Permission of instructor required. Instructor: Staff. 3 units.

536. 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 350L or equivalent. Instructor: Chakrabarty. 3 units.
537. **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 280L and Electrical and Computer Engineering 331L or equivalent. Instructor: Staff. 3 units.

538. **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 350L or equivalent. Instructor: Chakrabarty. 3 units.

539. **CMOS VLSI Design Methodologies.** Emphasis on full-custom digital ASIC design using CMOS technology. Extensive use of CAD tools for IC design, simulation, and layout verification. Includes techniques for designing high-speed, low-power, easily-testable circuits. Semester design project: Student groups design and simulate simple custom IC using Mentor Graphics CAD tools. Formal project proposal, written project report, and formal project presentation required. Prerequisites: ECE 230L, ECE 250L, ECE 270L, and ECE 280L; Math 353; one of Stat 130 or Math 230 or ECE 555; Phys 152L; Chem 101DL; one of Bio 201L, 202L or 311; ECE 331L and ECE 350L. Some background in computer organization is helpful. Instructor: Chakrabarty. 3 units.

541. **Advanced Optics.** 3 units. C-L: see Physics 621; also C-L: Biomedical Engineering 552

545. **Foundations of Nanoelectronics & Nanophotonics.** Theory and applications of nanoelectronics and nanophotonics. Quantum dots and wells, metal nanoparticles, organic - inorganic interfaces, graphene, next generation transistors, light emitters, and sensors. Prerequisite: Electrical and Computer Engineering 230L and 270L or equivalent. Instructor: Brown. 3 units.

546. **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 230L or equivalent. Instructor: Brown. 3 units.

549. **Optics and Photonics Seminar Series.** Weekly seminar on the current research topics in the field of optics and photonics. Instructor: Staff. 3 units. C-L: Biomedical Engineering 609, Physics 549

550D. **Fundamentals of Computer Systems and Engineering.** Fundamentals of computer systems and engineering for Master's students whose undergraduate background did not cover this material. Topics covered include: Digital logic, assembly programming, computer architecture, memory hierarchies and technologies, I/O, hardware implementation in VHDL, operating systems, and networking. Undergraduates may not take this course, and should take ECE 250, ECE 253, and/or ECE 356 instead. Instructor: Hilton. 3 units.

551D. **Programming, Data Structures, and Algorithms in C++.** Students learn to program in C and C++ with coverage of data structures (linked lists, binary trees, hash tables, graphs), Abstract Data Types (Stacks, Queues, Maps, Sets), and algorithms (sorting, graph search, minimal spanning tree). Efficiency of these structures and algorithms is compared via Big-O analysis. Brief coverage of concurrent (multi-threaded) programming. Emphasis is placed on defensive coding, and use of standard UNIX development tools in preparation for students' entry into real world software development jobs. Not open to undergraduates. Instructor: Hilton. 3 units.

552. **Advanced Computer Architecture I.** 3 units. C-L: see Computer Science 550

553. **Compiler Construction.** Covers the fundamentals of compiler design. Students will develop a working compiler, writing all stages required to take source code as input and produce working assembly as output: lexical analysis, parsing, type checking, translation to intermediate representation, instruction selection, liveness analysis, and register allocation. Students are expected to have a strong programming background prior to taking this course, as writing a compiler is a significant programming task. Prerequisites: Electrical and Computer Engineering 250L or Computer Science 250 or (ECE 550D and ECE 551D). Instructor: Hilton. 3 units. C-L: Computer Science 553

554. **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 250L or equivalent. Instructor: Sorin. 3 units. C-L: Computer Science 554
555. 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 216. Instructor: Trivedi. 3 units. C-L: Computer Science 555.


558. Computer Networks and Distributed Systems. 3 units. C-L: see Computer Science 514.

559. 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: ECE 230L, ECE 250L, ECE 270L, and ECE 280L; Math 353; one of Statistics 130 or Math 230 or ECE 555; Physics 152L; Chemistry 101DL; one of Biology 201L, 202L, or 311; and ECE 350 and ECE 331L. Instructor: Derby. 3 units.

571. 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 270L. Instructor: Carin, Joines, Liu, or Smith. 3 units.


573. 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 270L or equivalent. Instructor: Joines. 3 units.

574. 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 270L or equivalent. Instructor: Joines. 3 units.

575. Microwave Electronic Circuits. Microwave circuit analysis and design techniques. Properties of planar transmission lines for integrated circuits. Matrix and computer-aided methods for analysis and design of circuit components. Analysis and design of input, output, and interstage networks for microwave transistor amplifiers and oscillators. Topics on stability, noise, and signal distortion. Prerequisite: Electrical and Computer Engineering 270L or equivalent. Instructor: Joines. 3 units.

577. 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 571 or consent of instructor. Instructor: Carin or Liu. 3 units.

578. 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 571), or consent of instructor. Instructor: Liu. 3 units.


582. 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 581 or equivalent with consent of the instructor. Instructor: Collins, Krolik, or Nolte. 3 units.

584. Acoustics and Hearing (GE, EL, IM). 3 units. C-L: see Biomedical Engineering 545

585. 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 581 or consent of instructor. Instructor: Nolte. 3 units.

587. Information Theory. Information theory is the science of processing, transmitting, storing, and using information. This course provides an introduction to mathematical measures of information and their connection to practical problems in communication, compression, and inference. Entropy, mutual information, lossless data compression, channel capacity, Gaussian channels, rate distortion theory, Fisher information. Useful for researchers in a variety of fields, including signal processing, machine learning, statistics, and neuroscience. Appropriate for beginning graduate students in electrical engineering, computer science, statistics, and math with a background in probability. Instructor: Reeves, Carin. 3 units. C-L: Statistical Science 563

590. 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 consent required. Instructor: Staff. 3 units.

590-1. Advanced Topics in Electrical and Computer Engineering. Opportunity for study of advanced subjects in electrical and computer engineering. 1 unit. Instructor: Staff. 1 unit.

611. Nanoscale and Molecular Scale Computing. Students study the design and analysis of nanoscale computing systems. Topics include nanoelectronic devices (e.g., graphene and carbon nanotube transistors, quantum dots, etc.), computational paradigms (conventional von Neumann, quantum cellular automata, quantum computing, etc.), microarchitecture and instruction set design specific to nanoscale systems, defect and fault tolerance, fabrication techniques (e.g., self-assembly), modeling and simulation methods. This course relies on current literature and student discussion. Prerequisites: Electrical and Computer Engineering 350, Electrical and Computer Engineering 511. Instructor: Dwyer, Lebeck. 3 units. C-L: Computer Science 624

631. Analog and RF Integrated Circuit Design, Fabrication, and Test. For students who have some experience in analog circuit design and want to fabricate and test an IC under faculty supervision. Typically taken over three semesters (Fall, Spring, Summer, or Fall, Spring, Fall) to accommodate design-fabricate-test cycle. Design cycle: students use Cadence or Mentor IC layout tools, and HSPICE or ADS simulation tools. Fabrication cycle: a detailed
test plan is developed. Test cycle: students access test facility appropriate for design and submit a report to the IC fabrication foundry. Co-requisite: ECE 539, or consent of instructor. Instructor: Brooke. Variable credit.

652. **Advanced Computer Architecture II.** 3 units. C-L: see Computer Science 650


676. **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 340L or 375. Instructor: Brady. 3 units.

681. **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 216, Statistical Science 130 or Mathematics 230, Computer Science 101, or consent of instructor. Instructor: Collins. 3 units.


686. **Adaptive Filters.** Adaptive digital signal processing with emphasis on the theory and design of finite-impulse response adaptive filters. Stationary discrete-time stochastic processes, Wiener filter theory, the method of steepest descent, adaptive transverse filters using gradient-vector estimation, analysis of the LMS algorithm, least-squares methods, recursive least squares and least squares lattice adaptive filters. Application examples in noise canceling, channel equalization, and array processing. Prerequisites: Electrical and Computer Engineering 581 and 582 or consent of instructor. Instructor: Krolik. 3 units.

688. **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: Krolik. 3 units.

722. **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 Electrical and Computer Engineering 521, Physics 464, or equivalent. Instructors: Stiff-Roberts. One course. 3 units.

781. **Advanced Topics in Signal Processing.** Instructor: Staff. 3 units.

784LA. **Sound in the Sea: Introduction to Marine Bioacoustics.** 4 units. C-L: see Environment 784LA; also C-L: Biology 784LA

891. **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.

899. 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 Dowell, Chair (142A Engineering); Research Scientist Kielb, Associate Chair; Associate Professor Mann, Director of Graduate Studies (238 Hudson Hall) Professors Bejan, Cocks, Curtarolo, Dowell, Hall, Marszalek, Needham, Shaughnessy, Tan, Virgin, Zauscher, Zhong; Associate Professors Bliss, Blum, Cummings, Ferrari, Franzoni, Howle, Mann Knight; Assistant Professors Chen, Hotz, Simmons, Zavlanos, Zhao; Assistant Research Professor Thomas; Senior Research Scientists Kielb; Adjunct Assistant Professor Stepp; Professors Emeriti, Pearsall, Hochmuth and Garg

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 http://www.mems.duke.edu.

Courses in Mechanical Engineering and Materials Science (ME)

512. Thermodynamics of Electronic Materials. Basic thermodynamic concepts applied to solid state materials with emphasis on technologically 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.

514. 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 529

515. 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 221L. Instructor: Curtarolo or Tan. 3 units.

517. 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: Staff. 1 unit.

518. Biomedical Materials and Artificial Organs (GE, BB). 3 units. C-L: see Biomedical Engineering 525
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<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tr>
<td>519</td>
<td>Soft Wet Materials and Interfaces</td>
<td>3</td>
<td>see Civil and Environmental Engineering 530</td>
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<td>524</td>
<td>Introduction to the Finite Element Method</td>
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<td>525</td>
<td>Nonlinear Finite Element Analysis</td>
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<td>see Civil and Environmental Engineering 630</td>
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<td>527</td>
<td>Buckling of Engineering Structures</td>
<td>3</td>
<td>see Civil and Environmental Engineering 647</td>
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<td>531</td>
<td>Engineering Thermodynamics</td>
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<td>532</td>
<td>Convective Heat Transfer</td>
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<td>Fundamentals of Heat Conduction</td>
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<td>Fundamentals of Thermal Radiation</td>
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<td>Compressible Fluid Flow</td>
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<td>Mechanics of Viscous Fluids</td>
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<td>541</td>
<td>Intermediate Dynamics: Dynamics of Very High Dimensional Systems</td>
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<td>542</td>
<td>Modern Control and Dynamic Systems</td>
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<td>Advanced Mechanical Vibrations</td>
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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.

545. 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; machine interaction and safety consideration. Prerequisites: Mechanical Engineering 542 or equivalent and consent of instructor. Instructor: Staff. 3 units.

546. 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 111 or 216 Consent of instructor required. Instructor: Ferrari. 3 units.

548. Multivariable Control. 3 units. C-L: see Civil and Environmental Engineering 648

555. 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.

571. 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: Mechanical Engineering 336L or equivalent, and Mathematics 353 or equivalent. Instructor: Bliss. 3 units.

572. Linear System Theory. 3 units. C-L: see Civil and Environmental Engineering 627

626. Plates and Shells. 3 units. C-L: see Civil and Environmental Engineering 646

627. 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.


632. 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 353 and Mechanical Engineering 336L. Instructor: Knight. 3 units.

639. 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.

643. 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.

668. 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.


672. 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 571. Instructor: Hall. 3 units.

676. Advanced Acoustics. Analysis methods in acoustics including wave generation, propagation, reflection, absorption, and scattering; sound propagation in a porous material; coupled structure acoustic systems; acoustic singularities: monopoles, dipoles, quadrupoles; radiation from flat surfaces; classical radiation and scattering solutions for cylinders and spheres; Green’s functions, Radiation conditions, Modal analysis; sound fields in rooms and enclosures: energy methods; dissipation in fluid media; introduction to nonlinear effects. This course is open only to graduate students with some prior background in acoustics and applied mathematics. Prerequisites: Mechanical Engineering 572 or equivalent. Instructor: Bliss. 3 units.

701. Capillarity & Wetting. 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: Chua. 3 units.

711. Nanotechnology Materials Lab. This course provides an introduction to advanced methods for the characterization and fabrication of materials, nanostructures, and devices. Cleanroom methods to be covered include lithography, evaporation, and etching. Characterization methods include electron microscopy, atomic force microscopy, X-ray photoelectron spectroscopy, and optical spectroscopy. Students will receive an overview of the techniques in the Shared Materials Instrumentation Facility through lectures and demonstrations. In the lab section, each student will engage in a project that focuses on those capabilities that are needed for their research, and will receive training and certification on that equipment. 3 units. C-L: Electrical and Computer Engineering 721

717S. 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 711S

718S. 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 712S

738. Mechanics of Viscous Fluids. Instructor: Staff. 3 units.

741. 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 542 or consent of instructor. Instructor: Garg. 3 units.

742. 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 541 or 544 or equivalent. Instructor: Virgin. 3 units.

758S. 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 from 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. Variable credit.

759. 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.

775. 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.

English

Professor Tennenhouse, Chair (312 Allen); Professor Mitchell, Director of Graduate Studies (316A Allen); Professor Armstrong, Associate Director of Graduate Studies (305A Allen); Professors Aers, Aravamudan, Armstrong, Baucom, Beckwith, Davidson, Ferraro, Hayles, Holloway, Khanna, Mackey, Moi, Moten, Pfau, Pope, Porter, Quilligan, Strandberg, Tennenhouse, Torgovnick, Wald; Associate Professors Mitchell, Moses, Psomiades, Sussman, Tetel, Wallace, Willis; Assistant Professors Baran, Vadde; Professor of the Practice Donahue; Lecturer Carlson-Hijuelos

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 Duke Law School. JD/MA students must apply for admission to the Duke Law School, and must combine relevant coursework 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-diasporic 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 http://english.duke.edu/graduate/.

Courses in English (ENGLISH)

505. 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 605
520S. 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: Staff. 3 units.

522S. 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: Staff. 3 units.

530S. 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 690S-1

532S. 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 625S

536S. Shakespeare: Special Topics. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 630S

538S. 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 632S

539S. Special Topics in Seventeenth-Century Literature. Topics vary by semester. Satisfies the Area I requirement for English majors. Instructor: Staff. 3 units.

540. Special Topics in Restoration and Eighteenth-Century Literature. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

540S. Special Topics in Restoration and Eighteenth-Century Literature (DS3). Seminar version of English 540. Instructor: Staff. 3 units.

545S. Romantic Literature: 1790 to 1830. Selected topics. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

546. Special Topics in Victorian Literature. Selected topics. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

546S. Special Topics in Victorian Literature. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

550S. British Literature since 1900. Selected topics. Satisfies the Area III requirement for English majors. Instructor: Staff. 3 units.

560. American Literature to 1820 (Selected Topics). Selected Topics. Satisfies the Area II requirement for English majors. Instructor: Staff. 3 units.

580S. Music in Literature and Philosophy. 3 units. C-L: see German 580S; also C-L: International Comparative Studies 527S

582S. Wittgensteinian Perspectives on Literary Theory. 3 units. C-L: see Literature 681S; also C-L: Philosophy 681S

583. Theater in London: Text. 3 units. C-L: see Theater Studies 520A

584. Theater in London: Performance. 3 units. C-L: see Theater Studies 540A

590-1. 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.

590-2. 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.

590-3. 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.

590-4. Special Topics in Criticism. Satisfies the Criticism, Methodology, Theory (CTM) requirement for English majors. Instructor: Staff. 3 units.
590-5. Selected Topics in Feminist Studies. Selected Topics in Feminist Studies. Satisfies English Area or Criticism and Methodology requirements for the English major as determined by Director of Undergraduate Studies. Instructor: Staff. 3 units.

590S-1. Special Topics Seminar I. 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.

590S-2. Special Topics Seminar II. 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.

590S-3. Special Topics Seminar III. Subjects, areas or themes that cut across historical eras, several national literatures, or genres, 1860 to the present. Satisfies the Area III requirement for English majors. Instructor: Staff. 3 units.

590S-4. 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.

730. Studies in Old English Literature. Intensive study of major Old English texts. Instructor: Aers or Beckwith. 3 units.

740. Studies in Middle English Literature. Instructor: Aers or Beckwith. 3 units.

742. Studies in Chaucer. Instructor: Aers or Beckwith. 3 units.

750. Studies in Renaissance Literature. Instructor: Aers, Beckwith, Porter, or Tennenhouse. 3 units.

752. Studies in Shakespeare. Instructor: Beckwith, Porter, or Tennenhouse. 3 units.


760. Studies in Augustanism. Instructor: Staff. 3 units.

762. Studies in a Major Augustan Author. Instructor: Staff. 3 units.

770. Studies in Romanticism. Instructor: Mitchell or Pfau. 3 units.

780. Studies in Victorianism. Instructor: Armstrong or Psomiades. 3 units.

782. Studies in a Major Nineteenth-Century British Author. Instructor: Armstrong, Mitchell, Pfau, or Psomiades. 3 units.

810S. Early Modernism 1870-1914. Challenges involved in considering 1870-1914 a literary period. Historicizing the concepts of idealism, realism and modernism, with special attention to the relationship between literature and painting. British literature in a comparative, European frame. Authors studied will vary from year to year, and may include Eliot, Ibsen, Wilde, Strindberg, Shaw, Hardy, Loti, Gide, Zola, Fontane, Rilke, Forster, Colette, Alain-Fournier, Proust, Woolf. Instructor: Moi or Moses. 3 units. C-L: Literature 740S

820. Studies in Modern British Literature. Instructor: Baucom, Moses, Torgovnick, or Vadde. 3 units.

830. Studies in American Literature before 1915. Instructor: Holloway, Wald, or Wallace. 3 units.

832. Studies in a Major American Author before 1915. Instructor: C. Davidson or Holloway. 3 units.

838. Studies in Modern American Literature. Instructor: Ferraro, Holloway, Mackey, Moses, Wald, or Wallace. 3 units.

840. Studies in a Modern Author (British or American). Instructor: Staff. 3 units.

850. Studies in Literary Criticism. Instructor: Graduate faculty. 3 units.

890S. Special Topics Seminar. Instructor: Staff. 3 units.

890T. Tutorial in Special Topics. Tutorials by a faculty member for two or more students having a regular study session with a professor. Consent of instructor and Director of Graduate Studies required. Instructor: Staff. 3 units.

Environmental Policy, University Program in

Alan Townsend, Dean of the Nicholas School of the Environment, Professor Kelly Brownell, Dean of the Sanford School of Public Policy; Professor Pfaff, Director of Graduate Studies (186 Rubenstein Hall); Professors Kramer, Mayer, Newell,
Pattanayak, Pfaff, Salzman, Vigdor, Vincent, and Wiener; Associate Professors Conrad, Pizer, Smith, Timmins, Whetten, and Weinthal; Assistant Professors Basurto, Bennear, Bermeo, Campbell, Jeuland, Johnson, and Patino-Echeverri; Professors Emeritus Healy and McKean; Professors of the Practice Maguire and Orbach; Assistant Professors of the Practice Gallagher and Shapiro; Research Professor Murray; Senior Research Scholar Mirovitskaya

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.

More information can be found at http://nicholas.duke.edu/programs/university-phd-program-environmental-policy.

Environmental Science and Policy

Alan Townsend, Dean; Assistant Professor Meyer, Director of Graduate Studies; Professors Albertson, Christensen, Clark, Di Giulio, Doyle, Gelfand, Hinton, Kasibhatla, Katul, Kramer, Newell, Oren, Pimm, Porporato, Reynolds, Richardson, Richter, Salzmann, Urban, Vincent, Wiener, Wolpert, Zhang; Associate Professors Ferguson, Pattanayak, Pfaff, Smith, Timmons, and Weinthal, Wernigreen; Assistant Professors Bennear, Bernhardt, Heffeman, Kumar, Meyer, Pan, Patino-Echeverri, Poulsen, Stapleton, Wright; Professor Emeritus Healy, Reckhow, Terborgh; Professors of the Practice Maguire, Von Windheim; Associate Professors of the Practice: Gallagher; Assistant Professors of the Practice Albright, Reid, Shapiro, Swenson; Research Professors Murray; Associate Research Professors Qian; Assistant Research Professors Palmroth; Lecturer Clark; Adjunct Professor Miranda; Adjunct Assistant Professor Way

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. 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. The 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. 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 should be consulted.

Nicholas 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 website 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 “Earth and Ocean Sciences” on page 120 for additional information.)

Courses in Environment (ENVIRON)

501. 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.
503. 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.

505. Tree Structure and Function. Designed primarily for graduate students and advanced undergraduates in areas of ecology, forestry or related disciplines who desire basic understanding of how plants (special focus on woody plants) function at various scales from molecules to canopies. Course will facilitate application of plant physiological principles in the students' specific areas of interest. Focus is on responses of water loss and carbon gain of plants to variation in their environment. Background in biology preferred. Instructor: Palmroth. 3 units.


517. 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 561

520. Resource & Environmental Economics I. 1.5 units. C-L: see Energy 520; also C-L: Economics 530, Public Policy Studies 576


520L. Resource and Environmental Economics. The application of economic concepts to private- and public-sector decision making concerning natural and environmental resources. 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 530L, Public Policy Studies 575L

524. Water Quality Health. 3 units. C-L: see Earth and Ocean Sciences 524; also C-L: Global Health 534, Energy 524

530. Remote Sensing in Coastal Environments. 3 units. C-L: see Earth and Ocean Sciences 530; also C-L: Civil and Environmental Engineering 574

531. Economic Valuation of the Environment. Quantitative course with focus on economic valuation of changes in environmental quality. Covers theoretical foundations of major nonmarket valuation methods and, through a series of problem sets, provides opportunities to develop skills applying those methods. Also covers a range of regression methods commonly employed in valuation studies. Prerequisite: ENVIRON 520 or equivalent and ENVIRON 710 or equivalent. Instructor: Vincent. 3 units.

532. Evaluation of Public Expenditures. 3 units. C-L: see Public Policy Studies 596; also C-L: Economics 521

533A. 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: Staff. 3 units.


537. Environmental Health. Introduction to environmental effects on human health. Focus on chronic effects of exposure to pollution and other stressors, the interaction between anthropogenic environmental changes and infectious diseases, and the relationship between human health and ecosystem health. Includes lectures from a variety of
Environmental Science and Policy  168

experts in this field from throughout the Triangle region. Course is designed to facilitate maximum student participation through discussion. For graduate and advanced undergraduate students. Instructor: DiGiulio/Meyer. 3 units.

538. 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 538, Public Policy Studies 582

539. 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: Mihaich/McMasters. 3 units.

540. 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 and Environmental Engineering 563

543A. Respiratory Proteins and the Environment. Molecular diversity in structure, function and evolution of respiratory proteins. Field trips to biodiverse areas of Costa Rica and coastal NC complement text and lectures. Covers molecular adaptations that underlie macroscopic biodiversity, blood functions and blood pathogens, oxidative and nitrosative stress. Lectures and readings on the balance between pathways for metabolic oxygen utilization and alternative disease-causing pathways. (Given at Beaufort.) Field trip to Costa Rica required. Prerequisite: one semester of organic chemistry or consent of instructor. Instructor: C. Bonaventura. 3 units.

543S. Water Cooperation and Conflict. 3 units. C-L: see Public Policy Studies 580S; also C-L: Global Health 533S, International Comparative Studies 580S

544S. Collective Action, Property Rights, and the Environment. 3 units. C-L: see Political Science 549S


548. Solid Waste Engineering. 3 units. C-L: see Civil and Environmental Engineering 672

550. Land Use Principles and Policy. 3 units. C-L: see Public Policy Studies 578

551DA. 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.

555. 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: Statistical Science 210B or equivalent. Instructor: Staff. 3 units.
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.

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.

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/ Harrell. 4 units.

Applying Economic Analysis for Environmental and Public Health Project Evaluation. 3 units. C-L: see Global Health 531; also C-L: Public Policy Studies 607

Biogeochemistry. 3 units. C-L: see Biology 564

Stormwater Science: Pollution, Pavement, and Precipitation. 3 units. C-L: see Civil and Environmental Engineering 565


Economic Evaluation of Sustainable Development. 3 units. C-L: see Public Policy Studies 574

Coastal Ecotoxicology and Pollution. 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: AP Biology, introductory biology, or consent of instructor; introductory chemistry or consent of instructor. Instructor: C. Bonaventura. 3 units.

Biodiversity Science and Application. 3 units. C-L: see Biology 565L

Environmental Politics. Environmental policy formation and implementation in comparative perspective. Topics include interest groups, environmental movements and parties, public opinion, political systems and institutions. Case students selected from the United States and other advanced industrialized countries and the developing world. Spring. Instructor: Albright. 3 units. C-L: Public Policy Studies 577, International Comparative Studies 577

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: Johnson. Variable credit. C-L: Biology 579LA, Earth and Ocean Sciences 579LA

Collective Action, Environment, and Development. 3 units. C-L: see Public Policy Studies 579S

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.

Energy and U.S. National Security. 3 units. C-L: see Public Policy Studies 583S; also C-L: Political Science 663S
585A. Fisheries Ecology. Current topics in fish and fisheries ecology, explored through lecture and discussion of primary literature. Participation in collaborative research and synthesis projects. Intended for master and doctoral students; undergraduates by permission of instructor. Prerequisites: basic knowledge of ecology and oceanography. Instructor: Staff. 3 units.

590. Special Topics. Content to be determined each semester. May be repeated. Instructor: Staff. Variable credit.

590A. Duke-Administered Study Away: Special Topics. Content to be determined each semester. May be repeated. Offered only in Beaufort. Instructor: Staff. Variable credit.

590LA. Duke-administered Study Away; Special Topics. Content to be determined each semester. May be repeated. Offered only in Beaufort. Instructor: Staff. 4 units.

590S. Special Topics. Seminar version of 590. Instructor: Staff. Variable credit.

590SA. 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. Variable credit.

593. 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.

615S. Environmental Issues & the Documentary Arts. 3 units. C-L: see Documentary Studies 615S; also C-L: Arts of the Moving Image 643S

621. Water Resources, Finance and Planning. Introductory course to water in the built environment, with basic treatment of hydrology, treatment, regulation, and planning of water resources. Course will serve as a survey course for non-water specialists, and a bridge course from hydrology to policy, management, planning, and finance, or vice versa for policy students interested in bridging to hydrology. Emphasis will be on applications of basic techniques common in management contexts. Instructor: Doyle. 3 units.

624. Agriculture and Sustainability: Feeding the Growing Human Population Today for the Future. Introduces agroecology through basic scientific knowledge of plant physiology and growth for crop production, crop diversity and breeding, and comparison of agricultural practices (industrial, subsistence, organic, sustainable). Covers resources needed for whole-plant growth, biomass output for human use including bioenergy, and impacts on ecosystems. Examines environmental sustainability through assessment of drawbacks and benefits of agricultural practices for human food and biofuel production. Applications include management plan for sustainable agroecosystems and forecast of crop agricultural practices in need of a future altered environment. Prerequisites: Intro Biology or Ecology. Instructor: Reid. 3 units.

626. River Processes. Course focuses on river processes and how rivers change and how to analyze rivers. Course is a mixture of hydrology, geomorphology, and ecology. Focus is on quantitative analysis of processes using simple modeling approaches. Problems will be drawn from policy and river management applications such as river restoration, channel design, dam management, and floodplain regulation. Instructor: Doyle. 3 units.

630. Transportation and Energy. 3 units. C-L: see Energy 630

631. Energy Technology and Impact on the Environment. Efficiencies and environmental impacts of both new and established energy sources and conversion methods. Consideration of alternative energy technologies, including electricity generation by fossil fuels, nuclear, solar, wind and water; space heating and cooling by traditional methods and by solar; and transportation energy in automobiles, mass transit and freight. Environmental consequences of energy choices on local, national and global scales, including toxic emissions, greenhouse gases and resource depletion. Instructor: Johnson. 3 units.

635. Energy Economics and Policy. 1.5 units. C-L: see Energy 635

636. Methods in Spatial Epidemiology and Demography. 3 units. C-L: see Global Health 636

637S. Population and Environmental Dynamics Influencing Health. 3 units. C-L: see Global Health 637S

638L. Environmental Life Cycle Analysis & Decision. 3 units. C-L: see Energy 638L

640. Climate Change Economics. This course explores the economic characteristics of the climate change problem, assesses national and international policy design and implementation issues, and surveys the economic tools necessary
to evaluate climate change policies. Discussion-oriented requiring high degree of student participation. Course objectives are increased comprehension of economic aspects of climate change and ability to apply tools of economic analysis to climate policy and the responses of firms and households to it. Course designed for graduate and advanced undergraduate students. Instructor: Pizer. 3 units. C-L: Public Policy Studies 585

642. Air Pollution: From Sources to Health Effects. Both urban outdoor air pollution and household indoor air pollution contribute significantly to global burden of disease. Course covers fundamentals about how major air pollutants are generated and transported in the atmosphere and how these pollutants affect human health. Relevant exposure assessment, toxicology and epidemiology case studies are discussed. Prerequisites: general chemistry; introductory-level statistics. Instructor: Zhang. 3 units.

646. Urban Ecology. Addresses how to understand urban areas as ecological and socio-ecological systems and the distinction between the study of ecology in and of cities. Examines both through theoretical lens of socio-ecological systems, in which humans and their actions are a component of, rather than disturbance imposed on, ecological systems. Applies theoretical and methodological tools to global, regional, and local urban issues. Prerequisites: One ecology course and one environmental social sciences course. Instructor: Heffernan. 3 units.

650S. Advanced Topics in the Conservation of Biodiversity. Current topics in conservation and biodiversity. Intended for graduate students; advanced undergraduate students admitted with permission of instructor. Prerequisite: introductory conservation biology or permission of instructor. Instructor: Pimm. 2 units.

658. Applied Qualitative Research Methods. Broadly covers qualitative and mixed methods research design, analysis, and interpretation. Students gather a limited amount of their own data and produce a pilot research project throughout the semester. Students learn to use NVivo10, a qualitative research software program. Instructor: C. Clark. 3 units.

665. Bayesian Inference for Environmental Models. 3 units. C-L: see Biology 665

666. Aquatic Geochemistry. 3 units. C-L: see Civil and Environmental Engineering 666

678. Population Ecology for a Changing Planet. Overview of the expanding field of population ecology, including the use of new bioinformatic tools to study topics such as the impacts of climate change on population dynamics, population growth and regulation, adaptive evolution, and emerging diseases. Lecture and discussion of case studies will evaluate current knowledge and productive research directions, highlighting analysis of observational and experimental data sets. Prerequisites: introductory statistics and calculus. Instructor: J. Clark. 3 units. C-L: Biology 678

680. Economics of Forest Resources. Core economic theory of forest management and application of theory to selected forestry policy issues. Course focuses on management of forests for timber production as well as for non-timber values. Concepts explored include policy challenges such as biodiversity conservation, deforestation, community forest management, and payments for ecosystem services. Two groups of economic tools will be used: non-market valuation methods and program evaluation techniques. Prerequisites: college-level calculus, microeconomics and statistics, as well as Excel proficiency. Instructor: Vincent. 3 units.

700. 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.

701. Forest Measurements. Course is designed to provide field and analytical measurement skills expected of professionals working in forest ecosystem management. Additional emphasis on habitat assessment and forest vegetation and wildlife identification. Extensive field work required. Instructor: Richter. 4 units.

703. 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.
705L. **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: Palmroth. 3 units.

706. **Wildlife Surveys.** With a focus on birds, reptiles, amphibians, and mammals, this course introduces students to a wide variety of wildlife survey methods and skills through both classroom lectures and hands-on experience in the field. Design, practical application, and post-survey data analyses for conducting wildlife surveys for research as well as for management. Limitations and advantages of various field monitoring techniques; learn to identify many common birds, herps, and mammals of season for this area. Significant time spent in the field. Instructor: Staff. 2 units.

708. **Silviculture Prescription.** Professional foresters meet management objectives through stand manipulation by using appropriate methods. Silviculture prescription is an operational plan that describes the goals, the silvicultural manipulations needed to achieve these goals, and the development of the stands over the projected period. Facing diverse management objectives and stand conditions, success in this planning process depends on understanding the underlying principles of tree growth and stand dynamics, but also relies on the intuitive knowledge that aids in assessing stand conditions and future development. Class is designed to provide the practical experience needed for developing the intuitive knowledge. Instructor: Palmroth. 2 units.

709A. **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 270A. (Given at Beaufort.) Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course. Instructors: Nowacek (Beaufort). 3 units.

710. **Applied Data Analysis for Environmental Sciences.** Graphical and exploratory data analysis; modeling, estimation, and hypothesis testing; analysis of variance; random effect models; regression and scatterplot smoothing; generalized linear models; resampling and randomization methods. Concepts and tools involved in data analysis. Special emphasis on examples drawn from the social and environmental sciences. Students to be involved in applied work through statistical computing using software, Stata or R. Instructor: Albright or Poulsen. 3 units.

711. **Energy and Environment.** 3 units. C-L: see Energy 711

712A. **Hydrocarbons: Production to Policy Seminar.** Field study of hydrocarbons production in and around Houston, Texas, with first-hand perspective of oil and gas from industry experts. Includes a field trip with a required fee for the trip. Instructor: Pratson. 1 unit.

713A. **Clean Energy Field Trip.** Field study of the clean energy industry around the San Francisco Bay area, California, with first-hand perspective from renewable energy experts. Includes a field trip with a required fee for the trip. Instructor: Pratson. 1 unit.

714. **Landscape Ecology.** Landscape ecology embraces spatial heterogeneity in ecosystems: how spatial pattern arises, how it changes through time, and its implications for populations, communities, and ecosystem processes. Course adopts task-oriented perspective, emphasizing concepts and tools for habitat classification, inventory and monitoring, modeling and interpreting landscape change, and site prioritization for conservation or restoration. Prerequisites: an intermediate course in ecology; introductory statistics helpful but not required. Fall. Instructor: Urban. 3 units.

715L. **Understanding Energy Models and Modeling.** Course aims to nurture basic modeling literacy by focusing on widely-used class of "bottom-up," optimization-based, energy models commonly used for economic, environmental, and technology assessments. Students will gain practical experience searching for relevant modeling data, constructing scenarios, and running an energy model. Will gain a working knowledge of model mechanics and experience asking the type of questions needed to evaluate quality of modeling results. Instructor: T. Johnson. 3 units.
716L. Modeling for Energy Systems. 3 units. C-L: see Energy 716L

717. Markets for Electric Power. Examines basic concepts and tools in economics and engineering necessary to understand the operation of power markets. Includes physical systems; industry structure and economic models to understand the supply side; operational reliability; long-term reliability; and, integration of renewables. Instructor: Patino-Echeverri. 3 units.

720. Land Conservation in Practice. Overview of applied conservation practices of land trusts including: completing real estate transactions, working with private landowners, fundraising, land monitoring and stewardship, evaluating conservation success, overview of emerging trends. Course will entail guest speaker presentations from a wide range of private conservation entities from NC and the Triangle region. Attendance is required on a 1-day field trip. Course assignments: group projects, papers and class presentations. Instructor: Urban/Swenson. 2 units.

721L. 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.

722. Hydrologic and Environmental Data Analysis. 3 units. C-L: see Earth and Ocean Sciences 722; also C-L: Civil and Environmental Engineering 761

723. Landscape Analysis & Management. This course is a task-oriented perspective on landscape ecology and management. The tasks include habitat classification, sampling designs for inventory and monitoring, site selection and prioritization, modeling landscape change, and integrated assessment. These practical tasks are couched in the logical framework of adaptive management. Course consists of lectures and hands-on exercises in the computer lab. Prerequisite: ENVIRON 714 or consent of instructor. Instructor: Urban. 4 units.

725S. 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.

727. Forests in the Public Interest Seminar. Discussion of current readings pertaining to forestry issues written about in national newspapers such as The New York Times, Washington Post, and Wall Street Journal, news magazines such as The Economist, and Slate, investigative reports in magazines such as the Atlantic Monthly, New Yorker, Independent, and classic essays; the sort of articles that are read by the educated public - including leaders in public, private and nonprofit sectors - and shape public opinion about forestry and forestry policy issues. Provides an opportunity for students with interests in forests to gain experience evaluating arguments related to forest issues and how they are portrayed in the nonscientific press. Instructor: Richter, Vincent. 1 unit.

728. Fire Ecology and Management Seminar. A wide range of wildland and forest fire seminars are organized for students to interact with leaders in the wide variety of environmental fields that work with fire issues: ecological science of fires, prescribed, fire, fire behavior, fire on federal and state public lands, fire economics, fire and restoration, and fire in history and in the future. Instructor: Richter. 1 unit.

734L. Watershed Hydrology. Introduction to the hydrologic cycle with emphasis on the influence of land use, vegetation, soil types, climate, and land forms on water quantity and quality and methods for control. Development of water balance models. Analysis of precipitation patterns, rainfall and runoff, and nonpoint source impacts. Statistical handling and preparation of hydrologic data, simulation and prediction models, introduction to groundwater flow, laboratory and field sampling methods. Instructor: Katul. 4 units.

739. Our Changing Atmosphere: From Air Pollution to Climate Change. 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. Prerequisite: one college-level course each in chemistry and calculus. Instructor: Kasibhatla. 3 units. C-L: Civil and Environmental Engineering 665
744. Ecology and Conservation of Streams and Rivers. Overview of ecological processes in flowing waters and application to conservation and management of these ecosystems. Lecture and discussion formats to integrate basic principles governing physical, chemical, and biological structure of streams and rivers with anthropogenic drivers of change and policy and management tools. Laboratories will provide hands-on experience in collection and analysis of physical, chemical, and biological data. Field and literature projects will enable students to focus on either basic or applied analysis techniques. Prerequisite: general ecology recommended. Instructor: Heffernan. 3 units.

745A. Climate Change in the Marine Environment. Exploration of climate change science focusing on marine ecosystems and inhabitants - specifically ocean acidification, warming and sea level rise. Factors causing climate change, and how those vary spatially, focusing on sensitive polar ecosytems and mar mammal populations. Critical examination of climate change modeling using EdGCM (research-grade Global Climate Model), focusing on how scientists use models, observations/theory to predict climate, and assumptions/uncertainty implicit in modeling. Discussion of potential human impacts incl consequences of sea level rise and potential increases in disease due to climate change. (Taught at Beaufort.) Grad students responsible for research paper. Instructor: Hunt. 3 units.

746A. Marine Conservation Summer Institute. Immersion in marine conservation biology and policy. Basic tools of marine conserv bio and policy for 21st Century society and 'anthropocene' epoch intertwined w/two week-long modules. Hands-on, team-based, experiential learning w/meaningful faculty-student engagement. Phenomena affecting maintenance and loss of biodiversity (climate change, habitat destruction); strategies for combatting threats to biodiversity; key concepts of social science and law for instituting conserv policy; unique capstone-position papers and stakeholder negotiation; grad students will critique position papers.(Given at Beaufort.) Prerequisites: AP Bio, Bio 202L, suggested policy and/or intro ecol, or instructor consent. Instructor: Nowacek. 0 units. C-L: Public Policy Studies 946A

752. Sustainability and Renewable Resource Economics. Economic theories of sustainability, contrasted with other scientific views. Focus on renewable resource economics, modeling, and management. Prerequisite: Environment 520. Instructor: Smith. 3 units. C-L: Economics 752

753LA. 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 373LA. (Given at Beaufort.) Prerequisites: introductory biology and chemistry. Instructor: Rittschof. 4 units.

754A. 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.

756. Spatio-Temporal Environmental Models. Spatio-temporal models are now being widely used for inference on environmental data. This course will consist of weekly topics with readings of new literature and application of models and software to data sets. We will specifically focus on spBayes in R. Students will each volunteer to lead one week, track down and distribute a data set, set up a model and provide a short demo on computation. Instructor: Clark. 2 units.

757. Current Issues in Protected Area Management. Principles of management of protected areas. Topics vary and include wilderness, national park, or international protected areas. Focus on legal and historical frameworks, ecological and social issues, and development and practical application of terrestrial protected area management techniques. Lecture and class discussion of topics. Required 1-day field trip to NC wilderness area. Undergraduates may enroll by permission of instructor. Prerequisite: introductory ecology. Instructor: Swenson. 3 units.

760A. 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: Staff. 1 unit.

761. 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 559. Instructor: Fay. 4 units.

762. Environmental Mega-Trends. Course investigates major, over-arching trends in environmental science, policy, thought, and practice and likely trajectories for the coming 25 years. Goal is to understand these trends and assess how changes in the environment might impact - and be impacted by - society, from the scale of individual decisions to global economies. Individual topics driven by emerging issues that are of most pressing interest but also that may not have immediately obvious connections to contemporary environmental discussions. Instructor: Doyle. 1.5 units.

763. 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.

764. 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 forecasting, soil-plant-atmosphere water flow models, ground water and heat flow in soils, and diffusion of gases from leaves into the atmosphere. Prerequisite: Mathematics 21 or equivalent or consent of instructor. Instructor: Katul. 3 units.

765. Geospatial Analysis for Coastal and Marine Management. Application course focusing on spatial analysis and image processing applications to support coastal and marine management. Covers benthic habitat mapping, spatial analysis of marine animal movements, habitat modeling, optimization of marine protected areas. Requires fundamental knowledge of geospatial analysis theory and analysis tools. Consent of instructor required. Prerequisite: Environment 559. Instructor: Halpin. 4 units.

766A. Ecology of Southern Appalachian Forests. Field trips to various forest ecosystems in the southern Appalachian Mountains. Species identification, major forest types, field sampling, and history of effects of human activities. Consent of instructor required. Instructor: Richter. 1 unit.

767. Entrepreneurial Experience. Teaches marketing, finance and business planning within the context of forming a start-up. Core concepts include: establishing a value proposition; identifying an opportunity; intellectual property and technology management; marketing & financing a start-up; and exiting a company. The course has a technology focus, but many of the concepts apply to any start-up activity. Students will form teams to go through all the steps required to form a business, stopping short of executing legal agreements to do so. The experience is an ideal springboard for students who want to start a company or be part of an early-stage company in the future. Instructor: von Windheim. 3 units.

768. GIS for Water Quantity and Quality Assessment. Spatial analysis and image processing applications to support water resources management: water quality, flooding, and water supply primarily at watershed scale. Topics include water resources data modeling, terrain modeling and processing, river and watershed network analysis, and geospatial modeling of hydrologic processes. Knowledge of geospatial analysis theory and analysis tools. Kumar. 3 units.

769. Hydrologic Modeling for Water Quantity and Quality Assessment. Hydrologic modeling concerns itself with understanding and prediction of different components of the hydrologic cycle by solving abstract representations of respective hydrologic processes. Students acquire an in-depth understanding of how and where hydrologic models can be used, and will be prepared to address water quantity and quality problems using computer models. Course will discuss in detail the assumptions, limitations and uncertainty associated with different modeling strategies. Course addresses both surface and ground water processes. Models discussed in course include TopModel, Stanford Watershed Model, HEC-HMS, SWAT, HSPF, RUSLE, SPARROW, PIHM, etc. Instructor: Kumar. 3 units.

C-L: Civil and Environmental Engineering 687

771L. GIS Field Skills. Covers integration of GPS and GIS technology for field data collection. Data is set up in ArcGIS in lab, exported to GPS units, field data to be collected, and imported back to GIS system. ArcGIS Personal Geodatabase is the fundamental data structure. Course covers data accuracy and precision and how to use base
stations to correct data differentially for highest possible accuracy. Will discuss how to determine what GPS unit is necessary for project accuracy needs. Prerequisite: ENVIRON 559. Instructor: Harrell. 2 units.

772LA. Biochemistry of Marine Animals. Functional, structural, and evolutionary relationships of biochemical processes of importance to marine organisms. Open to undergraduates only under Biology 372LA. (Given at Beaufort.) Prerequisites: AP Biology, introductory biology, or consent of instructor; and Chemistry 101DL or introductory chemistry equivalent. 6 credits. Variable credit. C-L: Biology 772LA

773LA. Marine Ecology. 4 units. C-L: see Biology 773LA

776A. 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 376A. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read or staff. 3 units.

776LA. Marine Mammals. Laboratory version of Environment 776LA. 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.

777A. 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 Puerto Rico is required. Instructor permission is required. Prerequisite: Introductory Biology. Instructor: Piniak. 3 units.

777LA. 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 375AL. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Staff. 4 units.

778LA. Physiology of Marine Animals. Variable credit. C-L: see Biology 778LA

779LA. Marine Ichthyology. Overview of the bony and cartilaginous fishes, including their taxonomy, anatomy, functional morphology, and physiology. Aspects of their relationship with humans, specifically how fish biology and life history affect this relationship. Lectures and discussion of current scientific literature, and field/lab experiences to explore and collect data on local fish populations. Quantitative genetic techniques to explore fish population and community structure. (Given at Beaufort.) Prior course work in biology is required or permission of instructor. Instructor: Nowacek. 4 units.

782. Foundations of Environmental Entrepreneurship. Focus of course is foundations of entrepreneurial activity within the context of environmental science and policy. Course concentrates on new enterprises based on substantial technology innovations with potential for high growth and funding by venture capitalists. Format is readings, lectures and case discussion with practical exposure to all basic operational tools required to start up and operate a company. Instructor: von Windheim. 3 units.

784LA. Sound in the Sea: Introduction to Marine Bioacoustics. Fundamentals marine bioacoustics w/focus on current lit and conserv issues. Topics incl: intro acoustics; acoustic analysis methods and quant tools; production/recording of sound; ocean noise; propagation theory; active/passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Lab focus on methodologies for generating, recording and analyzing marine sounds. Grad students responsible for addtl acoustic analyses and results prep for student projects plus preparation addtl lit review/critique. Taught in Beaufort. Prereqs: AP or Intro Bio or consent; Phy 41L or 161L (or equiv) or consent. Instructor: Nowacek. 4 units. C-L: Biology 784LA, Electrical and Computer Engineering 784LA
786A. 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 749A, Political Science 707A

787A. 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 272A. (Given at Beaufort.) Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Johnson. 3 units.

788LA. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 377LA or Biology 777LA. Open to undergraduates only under Biology 377LA. Four credits (fall, spring, and Summer Term II); six credits (Summer Term I). (Given at Beaufort.) Prerequisite: AP Biology, introductory biology, or consent of instructor. Instructor: Kirby-Smith. Variable credit. C-L: Biology 777LA

790. Special Topics. Content to be determined each semester. May be repeated. Instructor: Staff. Variable credit.

790SA. Duke-administered Study Away; Special Topics. Content to be determined each session. Instructor: Staff. Variable credit.

795. Community-Based Environmental Management Practicum. Course is designed for students who wish to learn theory, skills and tools necessary for working with communities to manage their own environment. Course includes in-class lectures, discussions of readings, guest speakers and an in-depth client project with a local community-based environmental organization. Topics will include: community organizing; assessing and capturing resources; participatory planning and evaluation; participatory monitoring; outreach and social marketing; and political action for environmental change. Second of two required courses for the Community-Based Environmental Management certificate (NSOE only). Prerequisite: ENVIRON 755. Instructor: Shapiro. 3 units.

798. Communicating Outside the Box: Effective Science Communications and Research Translation Skills. Course primarily aimed at late-stage doctoral students who wish to translate their own research to audiences outside of the academy. Students will develop skills to effectively communicate science and research to non-academic audiences using a variety of methods and will develop and implement a research translation/communication strategy for their own research. Specific topics include underlying theories and frameworks, science and advocacy, environmental justice/community-based research, science and K-12 education, expert testimony, communicating with media, and communicating with policy makers. Prerequisite: consent of instructor. Instructor: C. Clark. 2 units.

799S. Topics in Ecological Genomics. This graduate seminar explores how genomic approaches are impacting research in ecology and environmental biology. The course is targeted to PhD or research-active masters students interested in genomics, genetics, ecology, ecotoxicology, conservation genetics, environmental sciences, and/or computational biology. Discussions will focus on case studies from primary literature, and computer labs will allow hands-on use of current programs. May be repeated. Wernegreen. 1 unit. C-L: Genome Sciences and Policy 799S

800. Professional Communications for MEM and MF Students. Skills-building in professional communication, emphasizing visual communication and speaking. Oral presentations, written document design, graphic display of information, presentation software, and giving and receiving constructive feedback on projects in these areas. Open only to MEM and MF students. Instructor: Vidra. 1 unit.

802. 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: Staff. 3 units.

803. Principles of Environmental Modeling. 3 units. C-L: see Biology 803

809. 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.

810. 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: Staff. 3 units.

811. Sustainable Systems Theory and Drivers. 3 units. C-L: see Energy 811

812. 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.

813. Advanced 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; 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 501. Instructor: Di Giulio. 3 units.

814. Integrated Case Studies in Toxicology. 1 unit. C-L: see Pharmacology and Cancer Biology 814

815. 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 533 and 847S. Instructor: Levin. 1 unit. C-L: Pharmacology and Cancer Biology 815

816. International Climate Change Negotiations Practicum. Climate change promises to impact almost every aspect of life on earth across the globe. It is an issue that, because of the diffuse nature of its causes and solutions, will require a global solution. Since the Rio Earth Summit in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) has been the primary forum for the negotiation of international agreements concerning climate change. Students will learn about primary issues involved in negotiation of international climate change agreements under UNFCCC and train them to take part as a stakeholder with the intention of developing students' analytical thinking through experiential learning at international level. Instructor: Shapiro. 3 units.

819. 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: DiGiulio. 3 units.

820S. Conservation Ethics. Students will delve into the tension between science and advocacy through the lens of environmental ethics. Students will gain a strong foundation in principles of environmental ethics, drawing from the rich literature on this topic from the fields of philosophy and ethics, environmental communications and education, and conservation ecology. Seminar-style course requires students to actively lead and participate in weekly discussions, write a series of essays and collaboratively design and initiate a semester project. Ultimately, the course is about reflecting on not just the academic literature and individual scenarios but seriously considering the role our own values play in our work. Instructor: Vidra. 3 units.

821. 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.

822A. 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: Kirby-Smith. 3 units.

823. Ecological Resilience and Ecosystem Management. Course provides an introduction to concepts of ecological resilience and its application to the management of ecological systems, and is intended for both PhD and MEM students. The course does not require formal mathematical training, but students are expected to engage the models used in this field. Course consists of lectures, discussion, and a group research project. Lectures will address fundamental theory, case studies, and empirical approaches used to understand the resilience of basic ideas, observations, and approaches to understanding the ecology of flowing water systems. Instructor: Heffernan. 3 units.

824A. Marine Conservation Biology. Introduction to marine conservation in a small island context with an exploration of how traditional and modern methods play out in practice. Most of the course will be taught in Palau, where students will meet traditional chiefs, fishers, state governors, NGO practitioners, scientists and politicians to hear their perspectives on marine conservation. The course will focus on the theory and practice of marine conservation, as exemplified by case studies in traditional management, marine protected areas, conservation of protected species and ecotourism. Taught at Beaufort. Trip to Palau required. Permission required. Instructor: Read. 3 units.

825LA. Marine Molecular Microbiology. Covers a broad overview of the ecological and biogeochemical role that microbes play in marine environments. Lab exercises focus on applying molecular techniques to the study of microbial ecology. (Offered at Beaufort.) Instructor: Hunt. 4 units.

827. 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: Emery. 3 units.

828A. Community-Based Marine Conservation in the Gulf of California. This is an experiential education course designed to allow students to learn first-hand about the accomplishments, challenges, and promises of community-based conservation in biodiversity hotspots in developing countries. Students have the opportunity to interact directly with individuals practicing marine conservation, and travel to unique, remote, and beautiful places of rich biological diversity that have made the Gulf of California a world-renown biodiversity hotspot. Instructor: Staff. 3 units.

829. 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: Smith. 3 units. C-L: Economics 753

832. Environmental Decision Analysis. Quantitative methods for analyzing environmental problems involving uncertainty and multiple, conflicting objectives. Topics include subjective probability, utility, value of information, multi-attribute methods. Students will apply these tools to an environmental policy decision in a group project. Prerequisite: introductory applied statistics or equivalent. Instructor: Maguire. 3 units.

834S. Environmental Social Science Research Workshop. Seminar format designed to give graduate students in environmental social sciences a venue to present research proposals and preliminary work. Emphasis is on application of social science research methods. Includes presentations by faculty and students. Intended for doctoral students in environmental social sciences. Students wishing to earn more than one credit will prepare an additional separate paper on topic with approval of instructor. Permission of instructor required. Instructor: Kramer or Smith. Variable credit.

835. Environmental Law. 3 units. C-L: see Energy 835

841. Ecological perspectives: Individuals to communities. 4 units. C-L: see University Program in Ecology 701; also C-L: Biology 841

842. Ecological perspectives: Ecophys to Ecosystems. 4 units. C-L: see University Program in Ecology 702; also C-L: Biology 842

847S. Seminar in Toxicology. 1 unit. C-L: Pharmacology and Cancer Biology 847S

850. 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 causal 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.

851S. Environment and Development Economics. Readings course surveys range of important natural resource and environmental issues in developing countries. Emphasizes use of economic principles to understand these issues and to formulate effective policy responses to them. Course has theoretical content, but deals with theory more qualitatively than mathematically. Provides an opportunity for learning how economic theory taught in other courses can be applied to natural resource and environmental issues in developing countries. Course objective: familiarize students with key portions of literature on environment and development economics and foster students’ abilities to read this literature critically and after graduation. Instructors: Vincent or Pattanayak. 1.5 units. C-L: Public Policy Studies 827S

852. Spatial Analysis for Ecologists. Descriptive and inferential statistics for spatial data as encountered in community and landscape ecology. Course covers spatial point patterns (e.g., clustering in plant communities), geostatistical samples (e.g., species-environment relationships inferred from spatially distributed samples), and lattices (e.g., maps, networks). Emphasis on hands-on applications with ecological data sets. Students may analyze their own datasets as a term project. Prerequisites: Introductory statistics, basic ecology, or consent of instructor. Taught in alternate, odd-numbered years, spring semester. Instructor: Urban. 3 units.

853. 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.

854. GIS Analysis for Conservation Management. This course explores applications of geographic and spatial analysis to conservation management issues such as habitat analysis, biodiversity protection assessments, and nature reserve design. The primary goals of the course are: (1) to critically assess the theoretical underpinnings of conservation analysis techniques; and (2) to develop a high level of proficiency in the application of geographic and spatial analysis techniques for conservation management problems. Prior experience with GIS systems and consent of instructor required. Instructors: Halpin and Urban. 3 units.

856. 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 301L, Mathematics 230, or equivalent. Instructor: Katul. 3 units.

857L. Satellite Remote Sensing for Environmental Analysis. Environmental analysis using satellite remote sensing. Theoretical and technical underpinnings of remote sensing (corrections/pre-processing, image enhancement, analysis) with practical applications (land cover mapping, change detection e.g. deforestation mapping, forest health monitoring). Strong emphasis on hands-on processing and analysis. Will include variety of image types: multi-spectral, hyper-spectral, radar and others. Prerequisite: familiarity with GIS. Instructor: Swenson. 4 units.
858. Multivariate Analysis for Ecologists. All of nature is multivariate, and this course embraces this richness. Two general approaches include classification (creating discrete groups) and ordination (emphasizing continuous trends in data). Ecological applications include habitat classification and species distribution modeling, clustering (i.e., community classification), and ordination-based approaches to integrated assessment. Prerequisites: Introductory statistics, basic ecology, or consent of instructor. Taught alternate (even-numbered) years, spring semester. Instructor: Urban. 3 units.

859. 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 559 and Environment 564. Instructor: Halpin. 3 units.

860SA. Political Ecology. Seminar to examine concept of political ecology as means of conceptualizing conservation and development conflicts and solutions. Intended to engage students with political ecology to strengthen usefulness, enrich possibilities, and improve participants ongoing research, collaborations and critical inquiries. Enrollment limited to graduate students. Taught at Beaufort. Instructor: Campbell. 3 units.

869. Environmental Law Clinic. Under supervision of Law clinic faculty, students work on current case and policy advocacy priorities as determined by Clinic's Intake Board. Cases and issues undertaken by the Clinic will vary by semester. 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 second or third semester in Nicholas School to enroll. Suggested for students to also enroll in ENVIRON 85, Environmental Law. Instructor: Longest and Nowlin. 4 units.

870. 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.

871. Fish As Models For Disease Research. Fish serve as models for disease research in genetic regulation of development, aging, cancer and high throughput screening of drugs and toxins. Due to their importance in human nutrition, fish are a central part of resource assessment following oil spills. To better appreciate fish as models and sentinels, this course will include coverage at all levels of biological organization and will acquaint the student with current methods, approaches and analyses. Instructor: Hinton. 4 units.

875A. Conservation Genetics. Application of evolutionary principles and molecular genetic tools for addressing conservation problems. Topics include genetic management of endangered species, wildlife forensics, contemporary evolution, anthropogenic selection, evolutionary impact assessments, genetic diversity and ecosystem function, and genetic-based biodiversity metrics. For graduate students with an interest in evolutionary biology, ecology, and conservation biology. Taught spring or fall. (Offered at Beaufort.) Instructor: Palkovacs. 2 units.

876A. 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.

882. Religion and Media. Examines leading theoretical contributions to the study of religious media broadly understood—from tracts to lithographs to television. Technology, mediation, network theory, ritual, and the public sphere receive careful attention. Attention focuses on leading cultural theory applied to the study of media as religious practice. Instructor: Morgan. 4 units.

891. Topics in Environmental Regulation. 1.5 units. C-L: see Energy 891

895A. Doctoral Student Seminar and Professional Development. Addresses topics of relevance to the professional development of PhD students in the Marine Science Conservation program. Topics addressed include: nature of
inter-disciplinary research, critical reading, grant writing, communication results to the public, mentoring students, and preparing manuscripts for academic journals. Offered at Beaufort. Instructor: Campbell. 1 unit.

898. Program Area Seminar. Required symposium in each program area. Students present master’s project research. Pass/fail grading only. Instructor: Staff. 1 unit.

899. 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.

905. DEL: 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.

906. DEL: Social Media for Environmental Communication. This six week distance learning course is offered by Duke Environmental Leadership. Students will become competent in the basic features and functions of popular social media tools. Students will understand the advantages and limitations of these tools and be able to choose the most appropriate ones for their programs. Students will become comfortable communicating through various social media tools and be able to incorporate these tools into a larger communication plan. 1 unit.

907. DEL: Writing for Environmental Professionals. Writing in environmental fields encompasses many genres, from policy memos to manuals, blog posts to interpretive signs. This course will allow you to refine and reflect on your writing process. For some, the course may serve as a tune-up; for others, a significant remodeling. Through six modules, on-line discussion, and a series of writing assignments, we will examine the more important aspects of any piece of professional writing: organization, use of evidence, clarity and cohesion, and incorporating feedback during the revision process. The goal is for your writing to become more powerful as a result of this work. Instructor: Cagle and Besch. 1 unit.

924. DEL: Agriculture and Sustainability. Introduces agroecology through basic scientific knowledge of plant physiology and growth for crop production, crop diversity and breeding, and comparison of agricultural practices (industrial, subsistence, organic, sustainable). Covers resources needed for whole-plant growth, biomass output for human use including bioenergy, and impacts on ecosystems. Examines environmental sustainability through assessment of drawbacks and benefits of agricultural practices for human food and biofuel production. Applications include management plan for sustainable agroecosystems and forecast of crop agricultural practices in need of a future altered environment. Prerequisites: Intro Biology or Ecology. Instructor: Reid. 3 units.

935. DEL: Social Science Research Methods & Design. Provides students with introduction to theory and practice of social science research methods and design. Intended for students who wish to learn both qualitative and quantitative research methods or who wish to combine natural and social science questions and methods into their research. Through lecture, discussion of readings and case studies, and review of research proposals of their peers, students will become proficient at not only social science theory, but at producing a sound and well-designed research proposal. Instructor: Shapiro. 3 units.

955. DEL: Community-Based Environmental Management. Course combines analysis of potential problems and pitfalls involved in community-based environmental management with discussion of the tools necessary to create and manage these projects. Focus is on discussion of academic literature with presentations of specific case studies and analysis of a community program in students’ proximity. 3 units.

958. DEL: Applied Qualitative Research Methods. Broadly covers qualitative and mixed methods research design, analysis, and interpretation. Students gather a limited amount of their own data and produce a pilot research project throughout the semester. Students learn to use NVivo10, a qualitative research software program. Instructor: Clark, Charlotte. 3 units.

967. DEL: Environmental Communications Planning. Acquire necessary tools for environmental professionals to write successful and comprehensive communications plans. Students engage in developing a full communications plan, including identifying stakeholders and appropriate media, crafting messages, and evaluating success of delivery. Complements DEL: Environmental Communications for Behavior Change. Online course. Instructor: Vidra. 1 unit.
975. DEL: Community Based Environmental Management in Mexico. Class offers students a focused introduction to the general history of rural common property governance and resource politics and management in Mexico and to the specific history and current context of community environmental management in Oaxaca. Requires participation in week long field trip (spring break) to Oaxaca (additional costs involved). Prerequisite: ENVIRON 755 or ENVIRON 955. Instructor: Shapiro, Elizabeth. 2 units.

976. DEL: Restoration Ecology: Practice and Principles. Class explores the fundamental principles of ecological restoration, environmental history, and social context. Faculty and students will use the restoration process as a framework and will focus on how the science informs the practice and vice versa. Requires participation in week long field trip over spring break to Hawaii. Instructor: Vidra. 2 units.

977. DEL: Classic Environmental Literature. Classic environmental literature shapes contemporary discourse about environmental issues. These texts also reveal our relationships with nature and offer new approaches to living with our environment. In this class, we will consider six classic works: Walden, A Sand County Almanac, Silent Spring, Limits to Growth, Small is Beautiful, and Our Common Future. Using close reading, discussion, and written reflection, we will analyze both the social and environmental context, as well as the enduring impact, of each work. Instructor: Cagle. 2 units.

979. 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.

985. DEL: Energy, Environment and the Law. Examines legal framework governing energy production and consumption in US, environmental issues associated with the nation’s energy sectors, and policy approaches for balancing energy needs with environmental protection. Three main sections: state utility regulation; energy resources for electricity generation; petroleum. Instructor: Monast. 3 units.

986. DEL: Environmental Ethics and Advocacy. Are you an environmentalist? Do we have a moral obligation to protect the planet? Can we imagine solutions to the environmental crises that are powerfully possible? In this course, we will step back from the details of ecology and conservation, energy and economics to consider the big picture of the environmental movement and our role within it. To inspire our thinking, we will draw on a collected set of essays that address climate change, specifically, and other readings to broaden our thinking about what it means to be an environmentalist. We will also examine the recent history of the environmental movement and the criticisms that have come from within and outside that movement. By examining the ethical frameworks of the contemporary environmental movement, students will gain a more nuanced perspective of the role and challenges of advocacy. Instructor: Vidra. 2 units.

987. DEL: Contemporary Environmental Issues. This course examines a broad range of contemporary environmental issues, including climate change impacts, endangered species conservation, and environmental health. This examination draws from the most-cited and recent peer-reviewed literature, current academic texts, and essays from popular literature. During the course, you will practice weighing evidence, synthesizing research, and articulating your perspective through written reflection and discussion. Discussions will also give you the opportunity to moderate conversations on hot-button issues. Instructor: Cagle. 2 units.

997. 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; Professor Kay, Director of Graduate Studies; Professors Alberts, Brannon, Churchill, Drea, Glander, Moorman, Myers, Nunn, Platt, Schmitt, Smith, Wray and Yoder; Associate Professors, Hare, Roth, and Taylor; Assistant Professor Boyer and Tung; Associate Professor of the Practice Digby, Director of Undergraduate Studies and Williams; Associate Research Professor Wall; Professors Emeritus Cartmill, Hylander and Simons; Visiting Assistant Professors Gosselin-Ildari and Teichrob; Adjunct Professors, Rose, Struhsaker, Teaford; Adjunct
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 organismal biology with a focus on primate and human evolution. Courses of study are tailored to meet individual needs, but all students will be expected to take courses in four of six core areas: evolutionary theory, behavior and ecology, paleontology, morphology and physiology, research design and statistics; and genetics and genomics.

For general information, visit [http://www.evolutionaryanthropology.duke.edu/](http://www.evolutionaryanthropology.duke.edu/) or e-mail mlsquire@duke.edu. To learn about research opportunities visit the websites of the faculty.

Courses in Evolutionary Anthropology (EVANTH)

514. Genomic Perspectives on Human Evolution. 3 units. C-L: see Biology 554

520S. Primate Morphology and Fossil Record. Survey of primate morphology/fossil record. Extinct fossil forms will be used to fill in gaps among major living groups or reveal specializations unseen among them. Implications of these patterns for 1) the relationships among living fossil primates and 2) origin and early evolution of the order Primates (as well as each major group of primates) in terms of historical timing, geography, and ecological influences. Methodological topics: 3D computer visualization; geometric analysis and biomechanical modeling of morphological variation; cladistics; phylogenetic comparative methods. Prerequisite: Evolutionary Anthropology 101/101D plus 200 or 300-level paleontology or anatomy course. Instructor: Boyer and Kay. 3 units.

522. 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 101 and 220, or consent of instructor. Instructor: Staff. 3 units.

530. Human Functional Anatomy. Basics of functional morphology (including elementary biomechanics), an overview of connective tissue structure and mechanics, and a systematic overview (from head to toe) of human anatomy from a functional perspective. Emphasis on connective and other tissues involved in functioning of the musculoskeletal system (primarily bone, cartilage, tendons, ligaments, and muscle). Prerequisite: Evolutionary Anthropology 101 and 333L or 334L. Instructor: Churchill. 3 units.

534L. 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. Pre-requisite: 100-level course in osteology or general anatomy. Instructor: Staff. 3 units.

537S. Orthopedic Biomechanics and Kinesiology. Seminar discussions and research addressing fundamental theoretical and practical aspects of clinical biomechanics of the human musculoskeletal system. Readings from primary literature will be assigned in class along with proposals for future research. Students will select a research question, develop an appropriate data collection protocol and collect preliminary data, the results of which are presented to the class as part of a formal poster presentation. Prerequisites: Evolutionary Anthropology 101, Physics 141L and 200 or 300-level anatomy course. Instructor: Schmitt. 3 units.

544L. 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 101; 200 or 300-level behavior or ecology course. Instructor: Glander. 3 units.

546S. Primate Social Evolution. Cological determinants of, and biological constraints on, social strategies and systems, with an emphasis on primates. Prerequisite: Evolutionary Anthropology 101 and 200 or 300-level behavior course. Instructor: Pusey. 3 units.

560S. Primate Cognition. Advanced readings and discussion in the evolution of primate cognition. Topics include evolution of social tolerance, communication, cooperation, competition, etc.; role these behaviors play in the evolution of cognitive abilities. Instructor: Hare. 3 units.

560SK. Evolution, Cognition and Society: How Evolution and Cognition Matter in Everyday Life. Using primary literature in evolutionary anthropology and cognitive science to discuss major societal events, behaviors and
issues. Topics include sex, prejudice, religion, music, abortion, illness, sexuality, global health, death, politics, economics and drugs. Emphasis on biological and cognitive perspectives to solving today's biggest personal, local and global problems. Taught at Duke Kunshan University. Instructor: Tan and Hare. 3 units.

580S. Ethics in Evolutionary Anthropology. Ethical issues and controversies in the study of evolutionary anthropology including treatment of primates in research; appropriate use of human genetic data, skeletal remains, and fossils. Professional ethics will also be addressed (e.g., ethical behavior in grant and paper reviewing, plagiarism, intellectual property). Course will make use of films, interviews and discussion primary and popular literature. Instructor consent required. Instructor: Williams. 3 units.

582S. 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: 200 or 300-level anatomy or morphology course and consent of instructor. Instructor: Williams. 3 units.

588S. Macroevolution. 3 units. C-L: see Biology 588S

590L-1. Special Topics Laboratory. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

590LS. Special Topics Laboratory. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

590S. Special Topics. Special topics in methodology, theory, or area. Consent of instructor required. Instructor: Staff. 3 units.

701S. Concepts in Evolutionary Anthropology -A. Graduate seminar for first year graduate students covering the foundation principles of evolutionary anthropology. Instructor: Staff. 1 unit.

702S. 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.

730. 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.

731. 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.

732S. Anatomy Seminar. Regular meeting of graduate students and staff in which current research problems in anatomy will be presented. Instructor: Staff. 1 unit.

734T. 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.

735S. 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.

746S. 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 units.
781S. **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.

790. **Topics in Physical Anthropology.** Instructor: Staff. 3 units.

790S. **Special Topics in Evolutionary Anthropology.** Selected topics in Evolutionary Anthropology. Topics vary by semester. Instructor: Staff. 3 units.

791. **Independent Study.** Directed reading and research. Consent of instructor required. Instructor: Staff. 3 units.

793. **Research in Evolutionary Anthropology.** A preceptorial course in various research methods in biological anthropology and anatomy. Consent of instructor required. Credit to be arranged. Instructor: Staff. Variable credit.

**Genetics**

See "Genetics and Genomics" below and also "Molecular Genetics and Microbiology" on page 234.

**Genetics and Genomics**

Professor Marchuk, *Director*; Associate Professor Haase, *Co-Director*; Associate Professor Ashley-Koch, *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), Donohue (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), Katsanis (cell biology), Keene (molecular genetics and microbiology), Kiehart (biology), Kornbluth (pharmacology and cancer biology), Kreuzer (biochemistry), Lew (pharmacology and cancer biology), Marchuk (molecular genetics and microbiology), Marks (pathology), McClay (biology), McCusker (molecular genetics and microbiology), Means (pharmacology and cancer biology), Mitchell-Olds (biology), Nevins (molecular genetics and microbiology), Nijhout (biology), Noor (biology), Perf (medicine), Pets (molecular genetics and microbiology), Rausher (biology), Shaw (chemistry), St. Geme (pediatrics), Sullenger (Surgery), Sun (biology), Thiele (pharmacology and cancer biology), Uyenoyama (biology), Vilgalys (biology), Willis (biology), Wray (biology), J. York (pharmacology and cancer biology), Young (ophthalmology); Associate Professors Aballay (molecular genetics and microbiology), Alspaugh (medicine), Ashley-Koch (medicine), Bejsovec (bio), Bowes-Rickman (cell biology), Cunningham (biology), Dietrich (molecular genetics and microbiology), Ferreira (molecular genetics and microbiology), Gregory (medicine), Haase (biology), Hauser (medicine), Klingensmith (cell biology), Kuehn (biochemistry), Lurzoni (biology), Markert (pediatrics), Matsunami (molecular genetics and microbiology), Pickup (molecular genetics and microbiology), Pei (biology), Poss (cell biology), Rushe (biochemistry), Schachat (cell biology), Seed (pediatrics), Steinbach (pediatrics), Valdivia (molecular genetics and microbiology), F. Wang (cell biology), Wernegreen (Nicholas school of environment), Winn (medicine), Yang (medicine), Yao (pharmacology and cancer biology); Assistant Professors Bagnat (cell biology), Bu (biology), Buchler (biology), Shen (biology), Coers (molecular genetics and microbiology), Crawford (pediatrics), Dave (medicine), Eroglu (cell biology), Fox (pharmacology and cancer biology), Gordan (biostatistics and bioinformatics), Jiang (pediatrics), Lechler (cell biology), Liedtke (neurobiology), Luftig (molecular genetics and microbiology) MacAlpine (pharmacology and cancer biology), Magwene (biology), Reddy (biostatistics and bioinformatics), Reinhardt (immunology), Schmid (biology), D. Sherwood (biology), Silver (molecular genetics and microbiology), Soderling (cell biology), Sullivan (molecular genetics and microbiology), Tobin (molecular genetics and microbiology), Tracey (cell biology), Unniraman (immunology), Volkan(biology), 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), Linney (molecular genetics and microbiology), Modrich (biochemistry), Resnick (National Institute of Environmental Health Science) and Steege (biochemistry)

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 more than 110 faculty with three adjunct faculty, and more than seventy-five students in the program, which was founded in 1967 and has been continuously supported by a training grant from the NIH for more than twenty-five years. Over the past several decades, the program has served as an important forum for training and education in genetics and genomics, including model systems (bacteria, yeast, fungi, drosophila, zebrafish, mouse), population genetics, and human genetics. The program has close links with the well-established Institute of Genome Sciences and Policy (IGSP) and the Center for Human Genome Variation 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, thirteen 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 relatively flexible. Students are required to take three full-semester courses — University Program in Genetics 778 (Genetic Approaches to the Solutions of Biological Problems) during fall of first and second years; University Program in Genetics 704 (Writing Grant Proposals) fall of second year — as well as two semesters of a literature-based genetics and genomic journal club class (University Program in Genetics 701), two seminar classes (University Program in Genetics 716, University Program in Genetics 750), one additional full-semester course with an emphasis in genetics, and two mini-courses selected from a variety of offerings. By the end of the second year, students should have completed 24 graded course credits. 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, and a biweekly student research seminar series (University Program in Genetics and Genomics 716). Students organize the distinguished lecturer series with advice from a faculty committee member, and students host the dinners with the distinguished speakers. Although a teaching experience (TA) is not required, interested students have the opportunity to develop teaching skills as an assistant for one semester. Finally, students complete a preliminary examination during the second year of graduate school and form their thesis committee.

Students admitted to the University 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 University 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: University Program in Genetics 778 (two semesters/8 course credits), University Program in Genetics 701, University Program in Genetics 704, 6 course credits in additional full-semester courses or mini-courses on any aspect of genetics (as approved by director of graduate studies).
- Research papers: at least one first author article in a refereed journal.
- Seminars: enrollment in University Program in Genetics 716 (including giving one presentation), University Program in Genetics 750, defense seminar.
- Examinations: preliminary exam, final exam/ defense.
- Event participation in a seminar series associated with University Program in Genetics 716 and University Program in Genetics 750 (which includes Distinguished Lecture Series).

For more information, visit [http://upg.duke.edu/](http://upg.duke.edu/).

Courses in the University Program in Genetics (UPGEN)

- **522. Critical Readings in Genetics and Genomics.** 3 units. C-L: Molec Genetics & Microbiology 522
- **532. Human Genetics.** 3 units. C-L: see Molec Genetics & Microbiology 532
533. Genetic Epidemiology. This course will cover traditional genetic epidemiologic methods such as study design, linkage analysis and genetic association. Instructor: Ashley-Koch. 3 units.

585S. 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.

658. Structural Biochemistry I. 2 units. C-L: see Biochemistry 658; also C-L: Cell and Molecular Biology 658, Cell Biology 658, Immunology 658, Structural Biology and Biophysics 658, Computational Biology and Bioinformatics 658

659. Structural Biochemistry II. 2 units. C-L: see Biochemistry 659; also C-L: Cell Biology 659, Immunology 659, Computational Biology and Bioinformatics 659, Structural Biology and Biophysics 659

668. Biochemical Genetics II: From RNA to Protein. 2 units. C-L: see Biochemistry 668; also C-L: Cell Biology 668, Immunology 668

701. 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: Ashley-Koch. 2 units.

704. Writing Grant Proposals. A course to prepare students in writing grant proposals. Instructor: Marchuk. 2 units.

716S. 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: MacAlpine. 1 unit.

725S. 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: Staff. 1 unit.

750S. 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: Ashley-Koch. 1 unit.

778. 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 778, Molec Genetics & Microbiology 778, Biology 728

786. Complex Traits and Evolutionary Genetics. Introduction to the principles of evolutionary genetics and variation of complex phenotypic traits. Genetic variation, neutral theory, natural selection, quantitative genetics, human population genetics, phylogenetic reconstruction, evolutionary genomics, and evolutionary bioinformatics. Prerequisites: Biology 20 or 25L or 202L. Instructor: Mitchell-Olds or Noor. One course. C-L: Genome Sciences and Policy, Modeling Biological Systems, University Program in Genetics and Genomics. 3 units.

787. 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: Mitchell-Olds. 3 units.


793. 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 the instructor required. Instructor: Staff (Genetics Program). 3 units.

794. 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 the instructor required. Instructor: Staff (Genetics Program). 3 units.

795. 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.

German Studies, Carolina-Duke Graduate Program
Professor Donahue, Chair (German); Professor Rasmussen Director of Graduate Studies (German); Professors Gilliam (music), Pfau (English); Associate Professor Laura S. Lieber (Religious Studies); Assistant Professors Gellen (German); Norberg (German); Associate Professor of the Practice Walther (German); Assistant Professor of the Practice Kahnke (German).

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.

A PhD in German studies is available in this program.

A total of sixteen courses (including those listed below), two of which will be credit for work on a dissertation, are required. Five core courses are required: German 700S (Foreign Language Pedagogy, Theories and Practices); German 715 (Cultural Foundations in German Studies to 1800); German 716 (Cultural Foundations in German Studies 1800 to the Present); Middle 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.

Courses in German (GERMAN)
501. 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 (203, 204, 212, or equivalent). Does not count toward the major or minor, or toward the fulfillment of the Foreign Language Requirement. Instructor: Rasmussen. 3 units.

502. 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 501. Not open for credit to undergraduate students who have taken Intermediate German (203, 204, 212, or equivalent). Does not count toward the major or minor, or toward the fulfillment of the Foreign Language Requirement. Instructor: Rasmussen. 3 units.

510S. Old Norse: Introduction to the Language of Viking Scandinavia. Introduction to the language of Viking Scandinavia, with primary goal of providing students with the linguistic tools needed to read the fascinating Norse literature in the original. Systematic presentation of grammar of Old Norse, and development of knowledge and skills needed to read and translate a considerable variety of Norse prose and, to a lesser degree, poetic texts. Also examines the relationship of Old Norse to other Germanic languages, as well as aspects of ancient Scandinavian
culture and history. No previous knowledge of linguistics is expected or assumed. Knowledge of German is moderately helpful but not necessary. Taught in English. Instructor: Keul. 3 units. C-L: Linguistics 562S, Medieval and Renaissance Studies 609S

511S. Theory and Practice of Literary Translation. 3 units. C-L: see Literature 640S

532S. Fin-de-siècle and Interwar Vienna: Politics, Society, and Culture. 3 units. C-L: see History 532S

560. 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 607, Linguistics 560

561S. 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 561S

575S. Hegel's Political Philosophy. 3 units. C-L: see Political Science 676S; also C-L: Philosophy 536S

576S. Nietzsche's Political Philosophy. 3 units. C-L: see Political Science 577S; also C-L: Philosophy 537S


586S. Literary Guide to Italy. 3 units. C-L: see Italian 586S; also C-L: Literature 542S, Arts of the Moving Image 640S

590S. Special Topics in German Studies. Special topics in German literature and cultural studies. Taught in English. Instructor: Staff. 3 units.

610S. 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, Wolfram), 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 610S

690. Special Topics in German Literature and Culture. Topics vary by semester. Instructor: Staff. 3 units.

690S. Special Topics in German Literature and Cultural Studies. Instructor: Staff. 3 units.

700S. 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: Kahnke. 3 units.

701. 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.

715. Cultural Foundations in German Studies, to 1800. First part of a two-semester sequence offering students a comprehensive, text-based survey of German 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: Rasmussen. 3 units.

716. Cultural Foundations in German Studies, to 1800 to present. Second part of a two-semester sequence offering students a comprehensive, text-based survey of 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: Donahue. 3 units.

721S. 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.

724. Form & Theory of the Lyrical Image: Goethe, Hölderlin, Mörike, Eichendorff, Trakl. An introduction to the basic forms of German lyric poetry after 1770, with taking into account competing interpretation models and theoretical models of poetry and of the concept of the image. The seminar will be held on German. Papers can be written either in German or English. Instructor: Pfau. 3 units.

740S. Introduction to Goethe. Major works of lyric, narrative, drama, and theory, throughout Goethe's career. Readings and discussions in German. Instructor: Staff. 3 units.

745S. 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: Staff. 3 units.

790-1. 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.

790-2. 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.

790-3. 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.

801S. 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: Staff. 3 units.

810S. Germanic Seminar. Topics and Instructors vary from semester to semester. Instructor: Staff. 3 units.

995S. Grad 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: Rasmussen. 1 unit.

Global Health

Associate Professor Woods, Director, Master of Science Program; Assistant Research Professor Watt, Associate Director, Master of Science Program; Professor Sikkema Director, Doctoral Certificate Studies

A doctoral 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 multisectoral 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 thirty-eight-unit curriculum includes six core courses, five electives, a ten-week (minimum) field experience to apply learned research methods, and a research-based scholarly thesis. It is designed as a three-to-four-term program.

The six core courses are:

- Global Health 701 (Global Health Challenges)
- Global Health 702 (Global Health Research: Design and Practice)
• Global Health 705 (Global Health Research: Quantitative Methods I)
• Global Health 707 (Global Health Research: Quantitative Methods II)
• Global Health 740 (Ethics for Global Health Research)
• Global Health 750 (Health Systems in Developing Countries)

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.

Students are also required to complete a fieldwork experience of at least ten weeks, approved by the director of the MSc-GH program, and a research-based scholarly thesis.

For more detailed course descriptions and elective options, visit https://globalhealth.duke.edu/education-and-training/graduate/courses/ or see the individual department’s listing.

Doctoral Certificate in Global Health

The global health doctoral certificate is an interdisciplinary certificate that provides an opportunity for doctoral students from across Duke University to engage in the field of global health through a combination of coursework, research-related field experience, and engagement with peers and faculty. On completion of the doctoral certificate, students will be prepared to complement their disciplinary scholarship with interdisciplinary knowledge of foundational global health concepts.

**Graduate Certificate Requirements**

The global health doctoral certificate requires completion of four courses, a field research experience, and ethics training.

- **The required courses are:**
  - Global Health 701 (Global Health Challenges)
  - Research Methods. From a menu of approved options or by approval from the DGHI director of doctoral studies.
  - Elective. One advanced (500+ level accepted, 700+ preferred) global health course from a menu of options that will include courses offered by DGHI and by departments across the university.
  - Global Health 870S (Global Health Doctoral Certificate Seminar). This new, variable-credit advanced seminar for doctoral students enrolled in the global health certificate will be a mix of journal club, presentations of student research, etc. For more detailed course descriptions, visit https://global-health.duke.edu/education-and-training/graduate/courses or see the individual department’s listing.

- **Field Research Requirement:** The goal of the field research requirement is to give students an in-depth understanding of the multiple contexts of health in underserved populations and to allow them to apply interdisciplinary knowledge and methodology. At least four weeks or 160 hours are required, and it must be approved, in advance, by the DGHI director of doctoral studies.

- **Ethics Training:** Seminars, workshops, and small group discussions will complement Responsible Conduct of Research training.

Courses in Global Health (GLHLTH)


510S. **Global Health and Genomics.** Explores the origins of, and current developments in global genomics research. Examples of genomics research and its applications with global health from medicine, agriculture, and environmental sciences. Students will gain familiarity with underlying science, critically analyze ethical, legal and social issues that arise in conduct of genomic research and policies surrounding design and conduct of genomic research, especially in developing countries and with indigenous peoples. Explore how design of genomic research and its commercialization affect access to products and services in the context of global health disparity. Familiarity with basic concepts of genetics and genomics preferred. Instructor: Chandrasekharan. 3 units. C-L: Genome Sciences and Policy 508S

530S. **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 532S

531. Applying Economic Analysis for Environmental and Public Health Project Evaluation. Course considers the importance of economic analysis, or cost-benefit analysis (CBA), for public policy assessments. Specific focus is on health and environmental policy, and the steps in identification / cataloguing, quantification, and monetization of impacts of potential policies and projects. Covers: Economic rationale for CBA; Basic principles for assessing the economic effects of projects; Techniques for valuing health and environmental impacts; Intergenerational/philosophical concerns related to CBA; Social discounting; Risk and uncertainty; Comparisons of CBA with other approaches (i.e. cost effectiveness analysis, multi-objective analysis). Instructor: Jeuland. 3 units. C-L: Public Policy Studies 607, Environment 563

533S. Water Cooperation and Conflict. 3 units. C-L: see Public Policy Studies 580S; also C-L: Environment 543S, International Comparative Studies 580S

534. Water Quality Health. 3 units. C-L: see Earth and Ocean Sciences 524; also C-L: Environment 524, Energy 524

538. Global Environmental Health: Economics and Policy. 3 units. C-L: see Environment 538; also C-L: Public Policy Studies 582

540. Global Health Ethics: Interdisciplinary Perspectives. Same as Global Health 210 but requires an additional paper; not open to students who have taken Global Health 210. Department consent required. Instructor: Whetten. 3 units. C-L: Public Policy Studies 638

550. Topics in Population, Health, and Policy. 3 units. C-L: see Public Policy Studies 633; also C-L: Sociology 534

570. 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: Staff. Variable credit. C-L: Public Policy Studies 643

571. Introduction to Global Maternal and Child Health. Provides solid foundation in global perspectives on maternal and child health research, practice, and policy. Utilize case analysis to examine critical health challenges facing women, children, providers, and policymakers in some of the world's most vulnerable communities. Course designed for graduate and advanced undergraduate students. Instructor: Green. 3 units.

590S. 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.

590S-1. 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.

593. Research Independent Study in Global Health. Individual research-oriented 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 to qualified juniors and seniors by consent of instructor and director of Global Health Certificate program. Instructor: Staff. 3 units.

636. Methods in Spatial Epidemiology and Demography. Use of analytical tools to understand spatial patterns in health and demographic events. Students acquire skills in spatial data analysis and interpreting spatial patterns. Students will understand fundamental concepts in spatial epidemiology and demography, including spatial autocorrelation, heterogeneity and bias, spatial interaction, and small area estimation; identify spatial and space-time clusters of events and judiciously evaluate hypothesis tests; and develop spatial regression models that appropriately account for spatial heterogeneity or explicitly model spatial autocorrelation. Success in this course requires prior knowledge of Geographic Information System and Statistics. Instructor: Pan. 3 units. C-L: Environment 636
637S. Population and Environmental Dynamics Influencing Health. Course examines population, health and environment (PHE) dynamics with focus on interactions in developing or transition economies. Theoretical and empirical approaches governing PHE dynamics from multidisciplinary perspectives, including geography, public health /epidemiology, demography, and economics. Students will obtain experience in design and analysis of PHE studies, and epidemiology of vector-born, chronic and enteric infections. Instructor: Pan. 3 units. C-L: Environment 637S

641. Non-Communicable Diseases in Low- & Middle-Income Countries: Trends, Causes and Prevention Strategy. Course will provide an overview of the recent (mid-20th century to the present) trends in non-communicable disease epidemiology. Focus on four major non-communicable disease categories as separate modules: cardiovascular, oncologic, diabetic and pulmonary diseases. Case studies used to highlight selected geographic differences. By using lectures, assigned readings and classroom discussion the course aims to provide the student with a firm understanding of the shifting disease burden and the landscape of stakeholders and interventions to prevent the same. Instructor: Bloomfield. 3 units.

660. Global Mental Health. Examination of global mental health from perspectives of culture, public health, epidemiology, human rights, policy, and intervention. Disciplines include cross-cultural psychiatry, medical anthropology, public mental health, and economics. Topics include ethics, stigma, cross-cultural classification of mental health, ethnopsychology, trauma, violence, disasters, and displacement. Populations include children, ethnic minorities, refugees, survivors of complex emergencies, and persons with chronic disease. Course highlights mixed-methods approaches to research and intervention evaluation. Designed for graduate students & advanced undergraduates. Prior research methods course recommended. Instructor: Puffer or Kohrt. 3 units. C-L: Psychology 611, Cultural Anthropology 611

671. Global Health and Health Systems in Africa. This course is designed to prepare students to work in, or pursue study of, the complex institutional environment of global health and health systems in Africa. The course braids together four topical strands: (1) the social, political, and economic context of the African continent; (2) African conceptions of the “public” and of “health” (3) the origins and evolution of African health systems; and (4) the impact on African health systems of transitions in global health governance. The course pursues these topics through case studies and team projects focused on issues of global health and health systems in representative African countries. Instructor: Toole. 3 units. C-L: Public Policy Studies 636

690. Special Topics in Global Health Studies. 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.

701. 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.

702. Global Health Research: Design and Practice. Course provides a foundation in study design, research question development, field implementation, measurement, validity and reliability. Quantitative and qualitative research approaches are examined. Students build critical skills in reading, interpreting and synthesizing scientific literature. The selection of appropriate measurements and survey development is emphasized and issues in field implementation explored. Instructor: Sullivan. 3 units.

705. GH Research: Quantitative Methods I. 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: Turner. 4 units.

707. Global Health Research: Quantitative Methods II. Builds on Quantitative Methods I. Provides common understanding of regression including linear, logistic, and general linear regression, use and interpretation of dichot-
omous and continuous variables, indicator terms, and interaction terms, and regression diagnostics. Required lab section. Instructor: Abdullah. 4 units.

708. Advanced Methods in Epidemiology. This course continues the curriculum presented in Quantitative Methods I & II and introduces some additional statistical methods used in epidemiology, including analysis of time to event data (survival analysis) and analysis of count and rate data (Poisson methods). In addition it provides an introduction of issues related to repeated measures data, causal inference, sensitivity analysis and other advanced topics in epidemiology. There is a data analysis lab section that will give students practical experience in these methods using a provided dataset. Instructor: Park. 2 units.

709. Introduction to Quantitative Methods for Program Evaluation. Course covers tools and techniques of program evaluation, and help students become familiar with key research methods employed to evaluate the effect of policies and programs. Teach students to critically read empirical research. Focus on quantitative impact evaluation, including experimental and quasi-experimental methods. Research designs will include: Difference in difference methods, Matching methods, Regression discontinuity designs, Instrumental variables, and randomized controlled experiments. Students learn to assess validity and limits of information presented to them. Prerequisite: GLHLTH 707 (Quant Methods II) or equivalent course that covers one semester of statistics. Instructor: Mohanan. 2 units.

721. Indigenous Medicine and Global Health. Explores indigenous medicine's role in global health and focuses on four interrelated topics: basic medical paradigms and practices, access and utilization in different regions, cross-cultural health delivery, and the complexities of medical pluralism. Course themes will be explored through lecture, discussion, small group case analyses, comparative analytical exercises, and workshops. Instructor: Boyd. 3 units. C-L: Cultural Anthropology 760

740. Ethics for Global Health Research. 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: Stewart. 2 units.

750. 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: Schulman. 3 units.

751. Developing Implementation/Operational Research for Improving Health Interventions. IR/OR: studies how to improve uptake, implementation, and translation of research findings into routine and common practices ('know-do' or 'evidence to program' gap); moves results from effectiveness studies and efficacy trials to real-world settings, obtaining information to guide scale-up; helps implementers apply lessons from a program in one context to developing a similar program in a similar environment. Course covers: framework of IR/OR; methods of identifying program implementation problems; how to organize and develop an IR/OR proposal; main study design, research methods, data collection and analysis used in IR/OR; approaches to capacity building for IR/OR in developing countries. Instructor: Tang. 3 units.

752. Introduction to Economics for Global Health. Economics is the study of making choices under resource constraints. This course is a primer on basic principles in economics that introduces a wide range of topics pertinent to issues in the healthcare and development sectors including preferences & utility, consumer demand, elasticity, income & substitution effects, choice under uncertainty, the economics of information (moral hazard, adverse selection), basics of theory of the firm, perfect competition, monopoly, and market failures. We will also discuss topics central to economics of health such as economics of insurance and models of provider behavior. Course is targeted to MSc-GH student who have no prior introduction to economics. Instructor: Mohanan. 2 units.

771. One Health: From Philosophy to Practice. Interdisciplinary course introducing construct of One Health as increasingly important to a holistic understanding of prevention of disease and maintenance of health. Includes discussion of bidirectional impact of animal health on human health, impact of earth's changing ecology on health. Learning objectives include 1) to describe how different disciplines contribute to the practice of One Health, 2) to
creatively design interdisciplinary interventions to improve Global Health using a One Health model. Course will include weekly 2-hour multi-campus seminar off-site at NC Biotechnology Center with on-campus discussion section using case studies to supplement the seminar. Instructor: Woods or Pan. 3 units. C-L: Environment 774

772. Global Health Research: Qualitative Field Methods. Course builds on material from GLHLTH702, but narrows focus to (1) qualitative field methods and 2) theories of the mixed method approach. A field-based, applied course designed to help students choose the qualitative field methods that best fit their project. Students will develop basic qualitative skills practiced by social sciences: ethnographic description, participant observation, interviewing. In addition, the course will introduce time allocation diaries and fieldnotes. Will discuss methods for collecting, analyzing, integrating, and reporting data from multiple sources. Finally, we will engage in ethical analysis as a core theme that unifies all stages of research. Instructor: Woods or Pan. 3 units.

781. 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.

790. 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.

790S. 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.

791. 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.

795. Connections in Global Health: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing global health issues. Teams may also include postdoctoral fellows, visiting global health fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Kramer. 3 units.

795-1. Connections in Global Health: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing global health issues. Teams may also include postdoctoral fellows, visiting global health fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Kramer. 1.5 units.

796. Connections in Global Health: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing global health issues. Teams may also include postdoctoral fellows, visiting global health fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Kramer. 3 units.

796-1. Connections in Global Health: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing global health issues. Teams may also include postdoctoral fellows, visiting global health fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Kramer. 1.5 units.
870S. Global Health Doctoral Certificate Seminar. This seminar is required for the Global Health Doctoral Certificate. Its contents will vary by semester but may include a combination of journal club, discussions with experts at Duke or external visitors, research presentations, and dissertation discussions. Instructor: Sikkema. Variable credit.

Graduate Liberal Studies

See listing under “Liberal Studies” on page 216.

Graduate Studies

Courses in Graduate Studies (GS)

705. Responsible Conduct of Research: Master's Degree Workshop. Graduate level training in research and professional ethics is a formal degree requirement for every Master's degree student in The Graduate School beginning with Fall 2013 matriculation. Topics include the Duke Community Standard, academic integrity, research ethics, plagiarism and proper citation methods, authorship and intellectual property, and Duke resources to assist graduate students. Entering Master's degree students must attend a four-hour Orientation on various RCR topics to include training within departmental groups led by faculty. Instructor: Staff. 0 units.

710. Responsible Conduct of Research: Campus Workshop. Graduate level training in research and professional ethics is a formal degree requirement for every Ph.D. student at Duke beginning with Fall 2003 matriculation. Topics include history of research ethics, academic integrity, preventive ethics, and Duke resources to assist graduate researchers. Entering Ph.D. students must attend ONE (Humanities and Social Sciences OR Natural Sciences and Engineering) of the full day RCR orientation workshops held each Fall, except basic medical science students who attend Graduate Studies 710A. Instructor: Staff. 6 units.

710A. Responsible Conduct of Research: Beaufort Workshop. Graduate level training in research and professional ethics is a formal degree requirement for every Ph.D. student at Duke beginning with Fall 2003 matriculation. Topics include history of research ethics, academic integrity, preventive ethics, and Duke resources to assist graduate researchers. Entering Ph.D. students in Basic Medical Sciences must attend a weekend retreat at Duke University Marine Laboratory in Beaufort, NC. Instructor: Staff. 12 units.

711. 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.

712. 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.

713. RCR Forum- Basic Medical Sciences. Required of 3rd year basic medical science graduate students as follow-up to GS710A RCR Orientation-Beaufort. Helps to fulfill RCR training requirements expected by NIH at least every four years. Uses didactic and small group interaction on scientific misconduct, questionable research practices, current topics in RCR, and interpersonal relationships in science, such as authorship, mentor/mentee relations, & responsibility of collaborators. Instructor: Chikaraishi and James. 4 units.

720. 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.
721. Integrated Oral Communication for International Students. For non-native speakers. Focus on the developing students' ability to participate actively in seminar settings and in conversations of professional and general interest. Includes practice in responding to field-specific questions, speaking articulately about one's field, and interacting on campus. Extensive listening practice using authentic academic sources. Significant focus on pronunciation diagnosis and communication improvement using technology such as e-voice clip exchanges. Individual conferences, videotaping, and peer review. Instructor: Staff. 4 units.

730. 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.

731. 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.

740. Improving Fluency and Pronunciation for International Graduate Students. Teaches the components of clear speech and effective communication skills. Emphasizes increasing intelligibility through building awareness of and increased control over individual vowel and consonant sounds as well as prosodic elements (phrasing, intonation, stress, rhythm). Individual pronunciation problems identified; focus on developing and working towards individual goals with instructor guidance and 1:1 conferencing. Builds fluency in presentations, networking, and interviews and improves pronunciation of field specific vocabulary. Intended for later-year PhDs. Instructor consent required. Instructor: Staff. 3 units.

745. Oral Communication and College Teaching Fundamentals for International Teaching Assistants. Designed for international students who will serve as International Teaching Assistants (ITAs). Teaches the components of clear speech and effective classroom communication skills in a variety of instructional settings. Emphasis on highly intelligible pronunciation of field specific terminology as well as lecture content. Other topics include effective learning activities, teaching methodology, instructional technology, grading criteria and personal and academic campus resources. Instructor consent required. Instructor: Harrison. 3 units.

750. Fundamentals of College Teaching. Designed for graduate students who may serve as Teaching Assistants; Topics include communication skills with faculty and students, learning styles and motivation, campus resources for personal and educational support, basic instructional technology, teaching methods and learning spaces, active learning, effective discussions and grading criteria. Instructors: Crumly/James. 1 unit. 1 unit.

755. College Teaching and Course Design. Designed for graduate students seeking to teach an independent course at Duke and beyond; topics include models of course design, syllabus construction, critical thinking, college student development, clarifying learning objectives, variety in assignments, small versus large class size, group dynamics, classroom assessment techniques, test construction, and grading rubrics. Instructor: James. 1 unit. 1 unit.

757. Teaching Writing in the Disciplines. Designed for graduate student Teaching Assistants or instructors and led by Thompson Writing Program staff. Topics include designing writing-intensive assignments in the discipline, staging the writing process, providing effective and efficient feedback, and grading. Related topics include managing group writing projects, discussing student writing in class, using models of the kind of writing assigned, and writing with graphs, tables and other visuals. Instructor: Staff. 1 unit.

758. Teaching Writing in the Disciplines II. Covers issues central to working with student writing in undergraduate contexts such as designing writing-intensive assignments, staging the writing process, providing effective and efficient feedback, and grading. Topics rotate and other topics determined according to graduate student interest, such as managing group writing projects and writing with graphs, tables and other visuals. Students develop a real or mock assignment in their field and get practice giving written feedback, discussing student writing in class, and using models of the kind of writing assigned. Those teaching their own courses are encouraged to develop materials for those classes. Instructor consent required. Instructor: Staff. 1 unit.
760. **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, developments of an electronic teaching portfolio and exploration of other instructional technology for college teaching. Instructor consent required. Instructor: Crumley. 1 unit.

762. **Online College Teaching.** Overview, case studies, comparison of different formats of online and hybrid courses. Evaluation and assessment of learning outcomes in online environments. Syllabus design and materials production for online courses. Intellectual property issues in online education. Concepts and practices for developing your own online course. Course director’s permission required. Prerequisite: At least one Graduate Studies course in college teaching, 750 or higher. Instructor: Crumley. 1 unit.

765. **College Teaching Practicum.** Video recorded peer teaching, observation and feedback. Course participants present a series of progressively longer and more interactive microteaching demonstrations. Effective use of visual aids in college classroom instruction. Demonstration of interactive presentations. Facilitation student-centered classroom discussion. Using appropriate student grouping strategies in classroom instruction. Prerequisites: Students must have done one of the following: Passed Graduate Studies 760, Graduate Studies 302, Participated in the PFF program or taught or TA’d a course at Duke. Instructors: Crumley, James and Parker. 1 unit.

770. **Topics and Careers in Higher Education.** Designed for advanced doctoral candidates exploring faculty or administrative careers in higher education. Topics include the range of faculty roles and responsibilities, academic governance, institutional cultures and mission, hiring and review processes, alternative academic careers, challenges for women and underrepresented minorities, and current issues in higher education. Instructor: James. 1 unit. 1 unit.

775. **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.

**History**

Professor Martin, Chair (224 Carr); Professor Sigal, Director of Graduate Studies (234 Carr); Associate Professor Lentz-Smith, Director of Undergraduate Studies (320 CARR); Professors Baker, Boatwright, Clark, Deutsch, Dubois, Edwards, French, Gaspar, Gavins, Hillerbrand, Ho, Humphreys, Korstad, Kuniholm, Lenoir, MacLean, Martin, Miller, Partner, Petroski, Ramaswamy, Reddy, Robisheaux, Sigal, Silverblatt, Starn, Tonio Lyon, Zanella; Associate Professors Balleisen, Ewald Gymph, Hacohen, Hall, Huston, Krylova, Lentz-Smith, Mazumdar, Neuschel, Olcott, Peck, Sosin, Stern, Thorne; Assistant Professors, Barnes, Bonker, Chappel, Hassan, Malegami, Tuna; Professors Emeriti, Chafe, Davis, Durden, English, Herrup, Koonz, Mauskopf, Nathans, Roland, Scott, Shatzmiller, Thompson, Witt, Wood, and Young

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 701, 702, 703, and 704.
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” on page 104.

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.

Courses in History (HISTORY)

501S. History of Sexuality. Explore history of sexuality around the globe, covering diverse time periods and regions. Examine methods and theories used in the study of sexuality, with attention to topics such as fertility, kinship, marriage, heterosexuality, homosexuality, birth control, sexology, and community formation. Instructor: Sigal. 3 units. C-L: Women's Studies 501S

502S. 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.

503. Research Methods in Japanese (B). 3 units. C-L: see Japanese 650; also C-L: Sociology 664

504S. East Asia's Twentieth Century. Historiographical review of 20th century East Asian history. Through weekly readings, study influential historical analyses of the period. Compare and evaluate historical approaches and key debates. Review methodologies of historical research on modern East Asia. Work with primary source materials in East Asian history. Research paper required. Instructor: Barnes or Partner. 3 units. C-L: Asian & Middle Eastern Studies 504S

505S. 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 515S, Women's Studies 509S

506S. Religion, Conflict and Holy War in the Pre-Modern West: Sects and Violence. Violence as a cultural phenomenon in the pre-modern world. How did enactment of violence, objectification by violence and immunity from violence produce social, political and religious identities? Topics: the dialectic of violence and peacemaking in the Christian tradition; aesthetics, performance and emotions in violent confrontations; the role of violence in state and community formation; religious groups as mediators and fomenters of conflict; violence in millenarian movements. Readings combine primary sources, secondary sources and theory. Students of anthropology, law and political studies will find topics of interest. Instructor: Malegam. 3 units. C-L: Medieval and Renaissance Studies 556S

507S. Asian Studies: Critical Introduction to Knowledge Fields and Methodologies. Examination of fundamental methodologies and historiography central to knowledge production about Asia in the Social Sciences, Humanities and Environmental Studies. An overview of nineteenth and twentieth century European discourses of Orientalism and Eurocentrism; the evolution of “Area Studies” models of inquiry and the bifurcations of Asian Studies; the impact of Cold War politics on the development of the field of Asian Studies in the United States; globalization, the environment and East Asia. Instructor: Mazumdar. 3 units.

509S. United States Policy in the Middle East. 3 units. C-L: see Public Policy Studies 503S

516. The Roman Republic. 3 units. C-L: see Classical Studies 532

519S. The Society and Economy of Europe, 1400 - 1700. The dynamism of the early modern world with a focus on Europe's recovery and expansion during the "long sixteenth century;" special attention to the relationship of population structures to the economy, agrarian expansion and the world of the village; capitalist trade and industry;
the "crisis of the seventeenth century;" family and household structures; the aristocracy; and the structure of life at court, in the cities and countryside. Instructor: Robisheaux. 3 units. C-L: Medieval and Renaissance Studies 570S

520S. Microhistory. Examines methods of micro-historical analysis, focusing on distinctive practices that define this popular form of history writing, including how to reduce the scale of analysis; interpreting clues as a "scientific paradigm"; treating culture as action; using historical contexts and theories; identifying historical actors; and crafting historical narratives. For advanced undergraduates, graduate students from any field interested in microanalysis, historical theory and method and story-telling. Requirements include short essays and major research paper based on primary sources from any field or period of history. Instructor: Robisheaux. 3 units. C-L: Medieval and Renaissance Studies 576S

523S. 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 575S

530S. Camera Asia. 3 units. C-L: see Visual and Media Studies 535S; also C-L: International Comparative Studies 531S

532S. 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 532S

533S. Greek History from the Bronze Age to the fifth century BCE. 3 units. C-L: see Classical Studies 524S

534S. Roman History from Romulus to Augustus. 3 units. C-L: see Classical Studies 532S


536S. The Russian Revolution. An analysis of the Bolshevik seizure of power in 1917 and the establishment of a revolutionary society and state during the 1920s. Instructor: Miller. 3 units.

537S. 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 515S, International Comparative Studies 537S

538. The Roman Empire. 3 units. C-L: see Classical Studies 536

539S. Roman History from Augustus through Late Antiquity. 3 units. C-L: see Classical Studies 536S

540S. Ethnohistory of Latin America. 3 units. C-L: see Cultural Anthropology 570S; also C-L: Literature 573S

541S. Intellectual History and Political Theory. Overview of current and historical approaches to intellectual history and the history of political thought, elucidating their theoretical foundations. Discussion of the major problems involved in the study of texts, ideas and culture and the vocabulary used by historians and political theorists. Readings in the classics of the field from Huizinga, Lovejoy, Febvre and Strauss to Skinner, Pocock and Bourdieu. Focus on joint projects of historians and political theorists. Instructor: Hacohen. 3 units. C-L: Political Science 573S

543S. 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. C-L: International Comparative Studies 543S

546. History of Poverty in the United States. 3 units. C-L: see Study of Ethics 561; also C-L: Public Policy Studies 528

561S. Africa in a Global Age. 3 units. C-L: see Cultural Anthropology 561S; also C-L: African and African American Studies 510S, Political Science 527S, International Comparative Studies 510S

562S. Courts, Wars, Legacies of Wars. 3 units. C-L: see Political Science 661S

567S. American Grand Strategy. 3 units. C-L: see Political Science 562S; also C-L: Public Policy Studies 501S

572S. Anthropology and History. 3 units. C-L: see Cultural Anthropology 501S; also C-L: Romance Studies 521S

577S. Historical and Philosophical Perspectives on Science. 3 units. C-L: see Philosophy 541S; also C-L: Literature 521S, Women's Studies 541S

582S. 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.

587. Modern Literature and History. 3 units. C-L: see French 556

590S. Topics in History Seminar. 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.

601S. Introduction to Jewish Studies. 3 units. C-L: see Jewish Studies 601S; also C-L: Religion 613S

610S. Research Seminar in History. This seminar is required of all entering first-year doctoral candidates in history. Instructor: Staff. 3 units.

620S. Research Seminar in History. This seminar is required of all entering first-year doctoral candidates in history. Instructor: Staff. 3 units.

630S. 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.

640S. 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.

741S. Spaces, Bodies, and Narratives: Mapping Religion in Colonial India. 3 units. C-L: see Religion 882S

761S. Topics in Modern Latin American Social and Political History. Empirical case studies and methodological and historiographical themes in nineteenth- and twentieth-century Latin America. Instructor: Staff. 3 units.

780S. Teaching Race, Teaching Gender. 3 units. C-L: see African and African American Studies 780S; also C-L: Women's Studies 780S, Literature 780S

790S-01. Topics 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.

790S-02. Topics 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.

790S-03. Topics 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 method-
logical, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

790S-05. Topics 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.

790S-06. Topics in Law and Society. The department offers a series of rotating courses, covering 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.

790S-07. Topics 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.

790S-08. Readings in Gender. The department offers a series of rotating courses, covering the history and historiography of various aspects of Gender. Written work is confined to methodological, conceptual, or historiographic essays. Topics vary, as do the instructors. Consent of instructor required. Instructor: Staff. 3 units.

790S-09. 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.

790S-10. 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.

790S-11. Topics 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.

790S-12. Topics 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.

790S-13. Topics in Methods and 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.

790S-14. 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.

791. 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.

792. 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.

800. 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.
850S. Anthropology and History. A continuation of History 572S/Cultural Anthropology 501S. Recent scholarship that combines anthropology and history, including culture history, ethnohistory, the study of mentalite, 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 535S or Cultural Anthropology 501S. Instructor: Staff. 3 units. C-L: Cultural Anthropology 735S

890S-01. Research Topics 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.

890S-02. Research Topics 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.

890S-03. Research Topics 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.

890S-04. Research Topics 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.

890S-05. Research Topics 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.

890S-06. Research Topics 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.

890S-07. Research Topics 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.

890S-08. Research Topics 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.

890S-09. Research Topics 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.

890S-10. Research Topics in Empires, Colonial Encounters. The department offers a series of rotating courses that offer students the opportunity to research and write on topics 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.

890S-11. Research Topics 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.
890S-12. Research Topics in Military History. 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.

890S-13. Research Topics in Methods and 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.

890S-14. 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.

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) program 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, women's studies, and other Duke departments and programs.

Requirements:

• The HPSTM core graduate seminar taught annually as a cross-listed course in history, literature, philosophy and women's studies (Literature 521S/History 577S/Philosophy 541S/Women's Studies 541S).
• 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.


Humanities
Dr. John Klingensmith and Dr. Douglas James, Codirectors of Graduate Studies

The master of arts program in humanities is an interdepartmental program tailored to the needs of individual students who pursue interdisciplinary graduate study in the humanities and interpretive social sciences. The candidate must define a theme, historical period, or problem for analysis, and then select appropriate coursework with the aid and approval of an academic advisor. Thirty course credits of coursework and three semesters of continuous enrollment are required for completion of the program (details on website). The degree may be earned with or without a thesis. Any thesis must follow the standard formatting guidelines of The Graduate School. The candidate who chooses not to submit a thesis must submit instead at least two substantial papers arising from coursework. Both thesis and nonthesis candidates must pass a final examination based on these papers or the thesis, with a minimum of three approved graduate faculty serving as the examination committee.

The master of arts program in humanities is designed for students who seek an intellectual or research focus not otherwise available within any existing graduate program at Duke. Applicants must hold a bachelor's degree in any field (or the equivalent to a US bachelor's degree) from an accredited institution, and must demonstrate sufficient background in humanities or interpretive social science to permit productive 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 joint JD/MA degree mechanism offered in conjunction with Duke Law School. 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, *Chair* (318 Jones); Professor Zhuang, *Director of Graduate Studies* (328 Jones); Professors Abraham (pathology), Buckley (pediatrics), Chao (medicine), Coffman (medicine), Cousins (ophthalmology), Frank (pediatrics), Gunn (medicine), Hall (dermatology), Haynes (medicine), He, Hoffman (pathology), Kelsoe, Krangel, Lyerly (surgery), Markert (Pediatrics), Pisetsky (medicine), Sampson (neurosurgery), Staats (pathology), St. Clair (medicine), Tedder, Weinberg (medicine), Weinhold (surgery), Yang (medicine), Zhuang; Associate Professors Lin (surgery), Rathmell (pharm), Taylor (medicine), Tomaras (medicine), Zhang, Zhong (pediatrics); Assistant Professors Ciofani, Coers (MGM), Hammer, Hollingsworth (medicine), Li, Reinhartd, Shinohara.; Research Professor Sarzotti-Kelsoe; Assistant Research Professors Poe, Zhu; Adjunct Professor Kepler; Adjunct Associate Professor Sarafova; Adjunct Assistant Professors Cook, Demarest, Gray, Haas

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. Immunology is by its nature a bridging science. The roots of immunology lie in the study of infectious disease, vaccine development, organ transplantation, immunity to malignancy, and immunotherapy. Modern research in immunology draws on recent advances in cell and molecular biology, biochemistry, genomics and informatics to determine how the immune system functions. In turn, immunology has contributed to understanding biological structure, eukaryotic gene organization and expression, signal transduction, and intracellular protein transport and assembly.

Research programs are available in many aspects of molecular and cellular immunology, including immunogenetics. The department is a participating member in the following university programs: cell and molecular biology, University Program in Genetics and Genomics, the Medical Scientist Training Program, Center for AIDS Research, molecular cancer biology, and the Developmental Biology Training Program.

The Department of Immunology has outstanding facilities for carrying out all aspects of immunologic research. A description of the PhD program, prerequisites for admission, and research in the department may be found at [http://immunology.mc.duke.edu](http://immunology.mc.duke.edu) or by e-mailing dgs-immunology@duke.edu.

**Courses in Immunology (IMMUNOL)**

544. **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 220 or Biology 201L. Instructor: Zhang. 3 units. C-L: Biology 515

601. **Immunology of Human Diseases.** This advanced course will cover the immune aspect of various human diseases including autoimmune diseases, allergy, tumor, inflammation and infectious diseases. The topics are divided into three categories: immunopathogenesis, host immunity against infections and tumor immunology. Prerequisite: Immunology 544. Instructor: He and St.Clair. 3 units.

658. **Structural Biochemistry I.** 2 units. C-L: see Biochemistry 658; also C-L: Cell and Molecular Biology 658, Cell Biology 658, University Program in Genetics 658, Structural Biology and Biophysics 658, Computational Biology and Bioinformatics 658

659. **Structural Biochemistry II.** 2 units. C-L: see Biochemistry 659; also C-L: Cell Biology 659, Computational Biology and Bioinformatics 659, Structural Biology and Biophysics 659, University Program in Genetics 659

668. **Biochemical Genetics II: From RNA to Protein.** 2 units. C-L: see Biochemistry 668; also C-L: Cell Biology 668, University Program in Genetics 668

701D. **Pillars of Immunology.** This course will cover discoveries of historical importance in the field of immunology through student presentations and discussions of classical papers. Intended for students seeking a PhD in immunology. F 10:20-11:20 am. Instructor: Krangel & Tedder. 1 unit.

731S. **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 Immunology 731S which is graded credit. Third through sixth year Immunology students, along with non-Immunology majors should register for Immunology 732S which is non-graded credit. Attendance is essential for both spring and fall terms. Permission of instructor is required. Instructor: Zhuang. 1 unit.

732S. 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 Immunology 731S for graded credit. Third through sixth year Immunology students, along with non-Immunology majors should register for Immunology 732S which is non-graded credit. Attendance is essential for both spring and fall terms. Permission of instructor is required. Instructor: Zhuang. 1 unit.

735. 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: Reinhardt. 1 unit.

736. 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: Shinohara. 1 unit.

791. Laboratory Rotation. Laboratory rotation for first year Immunology graduate students, first semester. Department consent required. Instructor: Staff. 1 unit.

792. Laboratory Rotation. Laboratory rotation for first year Immunology graduate students, second semester. Department consent required. Instructor: Staff. 1 unit.

800. 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: lymphocyte development; molecular structure and genetic organization of immunoglobulins, histocompatibility antigens, and T-cell receptor; antigen receptor signaling; properties of antigens; inflammation and nonspecific effector mechanisms; cellular interactions and soluble mediators in lymphocyte activation, replication, and differentiation; regulation of immune responses. Required course for students specializing in immunology. Consent of instructor required. Prerequisite: recommended, Imm244 or equivalent. Instructor: Li. 3 units.

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, policy, 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 Information Science and Information Studies 250S (Critical Studies in New Media).
- Demonstration of technical skills development through completion of Information Science and Information Studies 240 or other evidence of competency as approved by DGS.
- Three courses from the approved elective course list (from at least two different departments).
• One formal research presentation coordinated through the ISIS director of graduate studies and documented via online website and presentation archive.
• Participation in at least four research forum events to be tracked by the ISIS director of graduate studies and program coordinator.

For more information, visit [http://isis.duke.edu/](http://isis.duke.edu/) or contact the Information Science and Information Studies Program at Duke University, Box 90400, 2204 Erwin Road, Durham, NC 27708-0400. (919) 668-1934; isis-info@duke.edu.

Courses in Information Science and Information Studies (ISIS)

535. Chinese Media and Pop Culture. 3 units. C-L: see Asian & Middle Eastern Studies 535
540S. Technology and New Media: Academic Practice. 3 units. C-L: see Visual and Media Studies 562S; also C-L: Art History 536S

551LS. Wired! New Representational Technologies. 3 units. C-L: see Art History 551LS

555S. Physical Computing. Seminar in the algorithmic art & aesthetics of the "computational," rather than the "clockwork universe," "artificial life & culture" and both natural and technological "evolutionary computation." Emphasis on the medial physicality of both the underlying processes and the finished work. A critique of art inspired by the complexity of the natural world, art which dynamically instantiates those dynamics in works liberated from the conventional keyboard, mouse and display. Hands-on development of projects using "industrial strength" C/C++ for Windows, analog-to-digital converters and a variety of sensors and actuators in both a computer classroom and a lab workshop. No prerequisites. Instructor: Gessler. 3 units.

560S. Digital Humanities: Theory and Practice. Digital humanities theory and criticism. New modes of knowledge production in the digital era for humanists. Authoring and critiquing born digital projects as part of a theoretical, critical, and historical understanding of a special topic or theme in the humanities. Hands-on use of digital media hardware and software in combination with theoretical and critical readings for content analysis of text, images, audio, video and to create digital archives, databases, websites, environments, maps, and simulations. Independent digital projects + critical papers as final deliverables. Instructor: Szabo. 3 units. C-L: Visual and Media Studies 550S

565S. New Media, Memory, and the Visual Archive. 3 units. C-L: see Visual and Media Studies 565S

575S. Generative Media Authorship - Music, Text & Image. Covers Generative Media in all its forms. Lectures, workshops, discussions, one semester-length project, shorter individual exercises and readings. Interdisciplinary Graduate Seminar with advanced undergraduates and MFA students with permission of instructor. Instructor: Seaman and Supko. 3 units. C-L: Visual and Media Studies 575S, Arts of the Moving Image 575S, Music 575S

580S. Historical and Cultural Visualization Proseminar 1. 3 units. C-L: see Visual and Media Studies 580S

581S. Historical and Cultural Visualization Proseminar 2. 3 units. C-L: see Visual and Media Studies 581S

590S. Special Topics in Information Science and Information Studies. Topics vary per semester. Information science and studies areas as understood historically, thematically, and in contemporary cultures. Theoretical readings coupled with hands-on work with technology and new media applications. Instructor: Staff. 3 units.

591. Independent Study. 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 an academic and/or artistic product. Consent of both the instructor and director of graduate studies is required. Instructor: Staff. 1 unit.

592. Independent Study. 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 an academic and/or artistic product. Consent of both the instructor and director of graduate studies is required. Instructor: Staff. Variable credit.

615S. Comparative Media Studies. 3 units. C-L: see Literature 625S; also C-L: Visual and Media Studies 625S

624S. Post-Digital Architecture. 3 units. C-L: see Literature 624S

630S. Phenomenology and Media. 3 units. C-L: see Literature 630S; also C-L: Art History 630S, Visual and Media Studies 630S, Arts of the Moving Image 631S

632S. Whitehead, Bergson, James. 3 units. C-L: see Literature 632S; also C-L: Art History 632S, Visual and Media Studies 632S, Arts of the Moving Image 632S
640. The History and Future of Higher Education. Examination of the long history, from Socrates forward, of debates on meaning, purpose, and access to higher education, with special emphasis on the role of humanistic, critical thinking as foundational to all aspects of higher education. Primary focus on Western tradition of postsecondary education, plus a look at different international and alternative models, including apprenticeship, vocational and skills training, monastic training, community-based learning, lifelong learning, and online peer-to-peer open learning. Instructor consent required. Instructor: Davidson. 3 units.

650S. Critical Studies in New Media. 3 units. C-L: see Visual and Media Studies 561S; also C-L: Literature 621S, Art History 537S


662S. Mapping Culture: Geographies of Space, Mind, and Power. History and practice of mapping as cultural practice and technique of world-building and historical and cultural representation. Emphasis on interplay of cartographic imagination, lived experience, historical and narrative power. Readings in mapping history, critical cartography, psycho-geography, art maps, cognitive mapping, network maps, and spatial theory as well as contemporary approaches and critiques to maps, culture, politics. Exploration of map-based visualizations as narrative/argumentative devices. Hands-on work with geographical information systems, digital mapping tools, data viz, and digital storytelling systems. Theory/practice seminar culminating in a final research project. Instructor: Szabo. 3 units. C-L: Visual and Media Studies 662S

666S. (Neosentience) Body as Electrochemical Computer. 3 units. C-L: see Visual Arts 510S; also C-L: Arts of the Moving Image 622S

670. Body Works: Medicine, Technology, and the Body in Early Twenty-First Century America. Influence of new medical technologies (organ transplantation, VR surgery, genetic engineering, nano-medicine, medical imaging, DNA computing, neuro-silicon interfaces) on the American imagination from WWII to the current decade. Examines the thesis that these dramatic new ways of configuring bodies have participated in a complete reshaping of the notion of the body in the cultural imaginary and a transformation of our experience of actual human bodies. Instructor: Lenoir. 3 units. C-L: Literature 623, Philosophy 570

673S. Computer Models and the Treatment of Psychiatric Disorders. 3 units. C-L: see Psychology 673S; also C-L: Computer Science 673S, Pharmacology and Cancer Biology 673S


691. Independent Study. Individual directed study in a field of special interest on a previously approved topic, under the supervision of a faculty member. Consent of the instructor is required. Instructor: Staff. Variable credit.

695T. Advanced Tutorial - Information Science + Information Studies. Advanced undergraduate and graduate tutorial under the supervision of a faculty member or members for two or more students working on related projects. Consent of instructor required. Instructor: staff. 3 units.

791. Individual Research in Information Science + Information Studies. Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

890S. Special Topics in ISIS. Subjects, areas, or themes that embrace a range of disciplines related to Information Science + Information Studies. Graduate Level. Instructor: Staff. 3 units.
Integrated Toxicology and Environmental Health Program (University Program in Environmental Health)

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, 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 CIIT 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. There is no difference in the eventual degree granted through either mechanism; both 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 US citizens or permanent residents. Non-US 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 coursework 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 533 (Essentials of Pharmacology, Toxicology, and Drug Discovery)
• Pharmacology 554 (Mammalian Toxicology) or Environment 501 (Environmental Toxicology)
• Pharmacology 815 or Environment 815 (Focused Topics in Toxicology)
• Pharmacology 733 (Statistics for Basic Biomedical Scientists)
• Pharmacology 847S-848S (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, NC, 27708; (919) 613-8078; toxicology@duke.edu; http://sites.nicholas.duke.edu/envhealth.

Interdisciplinary European Studies
Professor Malachi Hacohen, Director

A certificate is available in this program.

The advances of interdisciplinarity have made it essential to provide a formal structure through which students from various disciplines in arts and sciences and the professional schools can obtain some grounding in other academic disciplines. The Center for European Studies aims to be a pioneer in the interdisciplinary configuration of area studies work toward an area-based, but not area-bound, perspective. In this context, the Center for European Studies offers a graduate certificate in interdisciplinary European studies. The graduate certificate is open to all advanced degree students who meet the necessary requirements.

To receive the graduate certificate in Interdisciplinary European Studies, the following criteria must be met:
• Five core courses with at least a 75 percent European studies content, taken in at least three different departments.
• Two-year participation in the European Studies Graduate Student Colloquium. The colloquium consists of a series of lectures and seminars at the center, and “participation” in this context means engagement in at least four Graduate Colloquium-sponsored activities per semester. (The CES coordinator will document participation.)
• Attain competency in one European language, other than English, equivalent to at least four semesters of college level study (advanced proficiency). The director, in consultation with the executive committee, will approve certification of language competency.
• Attain competency in a second European language, other than English, equivalent to at least two semesters of college level study (intermediate proficiency). The director, in consultation with the executive committee, will approve certification of language competency.
• A significant focus on European studies-related issues in dissertation work.
• A faculty member with European expertise must also be a member of the student’s dissertation committee from outside the student’s home department.

If there is a question as to whether the course meets the 75 percent European content requirement, such determination will be made by the CES director. The student’s thesis advisor shall determine whether the requirement for a significant focus on European studies-related issues in dissertation work has been met by the student. The director of the center, as well as the dean of The Graduate School will sign the certificate; appropriate notation is made on the student’s transcript. For any questions, contact the Center for European Studies at the John Hope Franklin Center, 2204 Erwin Road, Box 90406, Durham, NC 27708; (919) 681-3262; http://www.jhfc.duke.edu/ces.

Interdisciplinary Medieval and Renaissance Studies
Professor Finucci (romance studies), Chair; Professor Longino (romance studies), Director of Graduate Studies; Professors Aers (English, Divinity), Beckwith (English, theater studies), Brothers (music), Bruzelius (art, art history and visual studies), Clark (religious studies), Gaspar (history), Finucci (romance studies), Grant (political science), Greer (romance studies), Longino (romance studies), Martin (history), Mignolo (romance studies), Porter (English, theater studies), Quilligan (English), Rasmussen (Germanic languages and literature), Robisheaux (history), Sigal (history), Silverblatt (cultural anthropology), Solterer (romance studies), Tennenhause (English), Van Miegroet (art, art history and visual studies), and Wharton (art, art history, and visual studies); Associate Professors Eisner (romance studies), Janiak (philosophy), Neuschel (history), McCarthy (music), Stern (history), and Woods (classical studies); Assistant Professors Galletti (art, art history and visual studies), Hassan (religious studies), Malegam (history), Riedel (Divinity), and Pak (Divinity); Professors Emeriti Bland (religious studies), Clay (classical studies), DeNeef
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 twelve 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; (2) attend twelve meetings of the Medieval and Renaissance Studies Colloquium; (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 Medieval and Renaissance studies courses outside of major department (discuss with director of graduate studies and thesis advisor). Courses must be taken for credit. In some cases, courses listed in the student’s major department may be counted, as for example when they are team taught by faculty from different disciplines, when they teach research methods or skills relevant to several disciplines, or when they are in a different discipline than that of the student. The director of graduate studies must be consulted in every such case.

• Attend twelve meetings of the Medieval and Renaissance Colloquium. The purpose of the colloquium is to encourage students, before the dissertation-writing stage, to interact with students and faculty in Duke departments beyond their own, and to become part of a broader Medieval and Renaissance studies community at Duke. This colloquium usually meets three times each semester and is led by a range of faculty members or distinguished visiting lecturers.

• Present a research paper at a Medieval and Renaissance studies workshop, colloquium, or conference at a local venue.

• Dissertation on a topic in Medieval and Renaissance studies (late antiquity through seventeenth 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 or program coordinator and visit our website at http://medren.trinity.duke.edu/cmrs/graduateRequirements.html.

For descriptions of cross-listed courses below, see the listings under the specified departments.

Courses in Medieval and Renaissance Studies (MEDREN)

504A. History of Netherlandish Art and Visual Culture in a European Context. 3 units. C-L: see Visual and Media Studies 506A

505A. History of Netherlandish Art and Visual Culture in a European Context. 3 units. C-L: see Visual and Media Studies 507A

507S. Live Images: Ancient and Medieval Representations of the Divine. 3 units. C-L: see Visual and Media Studies 533S; also C-L: Religion 552S, Classical Studies 558S

522. Music in the Middle Ages. 3 units. C-L: see Music 551

523. Topics in Renaissance Music. 3 units. C-L: see Music 552

524. Music in the Baroque Era. 3 units. C-L: see Music 553
550. 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.

551. 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.

556S. Religion, Conflict and Holy War in the Pre-Modern West: Sects and Violence. 3 units. C-L: see History 506S

570S. The Society and Economy of Europe, 1400 - 1700. 3 units. C-L: see History 519S

575S. Religion and Society in the Age of the Reformation. 3 units. C-L: see History 523S

576S. Microhistory. 3 units. C-L: see History 520S

590. 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.

590-1. Topics in Early Modern Studies. 3 units. C-L: see French 590

590S. 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.

590S-1. Topics in Romanesque and Gothic Art and Architecture. 3 units. C-L: see Art History 590S-3

590S-2. Topics in Italian Renaissance Art. 3 units. C-L: see Art History 590S-4

605. Introduction to Old English. 3 units. C-L: see English 505

607. History of the German Language. 3 units. C-L: see German 560; also C-L: Linguistics 560

608S. Medieval and Renaissance Latin. 3 units. C-L: see Latin 508S

609S. Old Norse: Introduction to the Language of Viking Scandinavia. 3 units. C-L: see German 510S; also C-L: Linguistics 562S

610S. Introduction to Medieval German: The Language of the German Middle Ages and Its Literature. 3 units. C-L: see German 610S

615S. Dante Studies. 3 units. C-L: see Italian 583S

625S. Chaucer and His Contexts. 3 units. C-L: see English 532S

630S. Shakespeare: Special Topics. 3 units. C-L: see English 536S

632S. Special Topics in Renaissance Prose and Poetry: 1500 to 1660. 3 units. C-L: see English 538S

642. Medieval Fictions. 3 units. C-L: see French 550; also C-L: Literature 541

647S. Latin Palaeography. 3 units. C-L: see Latin 584S

648. The Legacy of Greece and Rome. 3 units. C-L: see Classical Studies 568

650. The Early Medieval Church. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Staff. 3 units.

651S. 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: Staff. 3 units.
653. 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: Staff. 3 units.

655. Early Christian Asceticism. 3 units. C-L: see Religion 634

659. Justice, Law, and Commerce in Islam. 3 units. C-L: see Religion 660; also C-L: African and African American Studies 575

662. Origen. 3 units. C-L: see Religion 632

664. Augustine. 3 units. C-L: see Religion 633

667. 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: Staff. 3 units.

669S. Medieval Philosophy. 3 units. C-L: see Philosophy 618S

672. 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 742. Open to juniors and seniors only. Instructor: Staff. 3 units.

675. 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: Staff. 3 units.

676. 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: Staff. 3 units.

677. Problems in Reformation Theology. Consent of instructor required. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Staff. 3 units.

679. 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.

680. Readings in Historical Theology. Also offered as a Divinity School course. Open to juniors and seniors only. Instructor: Staff. 3 units.

682. 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: Staff. 3 units.

690S-1. Special Topics is Middle English Literature: 1100 to 1500. 3 units. C-L: see English 530S

690S-2. Topics in Renaissance Studies. 3 units. C-L: see Italian 590S-1; also C-L: Art History 590S-2

825. Research Colloquium in Medieval and Renaissance Studies. Credit grading only. Instructor: Staff. 3 units.

890S. Topics in 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: Staff. 3 units.

**Latin American and Caribbean Studies**

Deborah Jenson, **Director**; Natalie Hartman, **Associate Director**; Antonio Arce, **Assistant Director**

A certificate is available in this program.

The Latin American and Caribbean studies certificate is open to MA and PhD students in any graduate or 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. (Please see assistant director for courses which count toward the certificate).
- 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 Assistant Director Antonio Arce, Box 90254, Duke University, Durham, NC 27708-0254; (919) 681-3981; 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 United States and overseas, as well as by 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. 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 both campuses.

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 US 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 website at http://clacs.aas.duke.edu/.

Courses in Latin American Studies (LATAMER)

590. 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.

590S. Special Topics in Latin American and Caribbean Studies. 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.

**Liberal Studies**

Donna Zapf, PhD, *Director*

Graduate Liberal Studies (GLS) offers a master of arts (AM) 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 master of arts degree in the GLS program 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 in seminars to an independent activity of the student's design.

Faculty members 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 *The Bulletin of Duke University: School of Medicine* or contact Kathryn M. Andolsek, MD, MPH, at DUMC Box 3915, Durham, NC 27710; (919) 668-3883; andol001@mc.duke.edu.

For further information about the master of arts degree in the Graduate Liberal Studies program, contact the GLS Program Assistant at Box 90095, Duke University, Durham, NC 27708; (919) 684-3222; dukegls@duke.edu. Additional information on the MALS degree is available on the GLS website at http://liberalstudies.duke.edu.

**Literature**

Professor Chow, *Chair*; Professor Lubiano, *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), Mignolo (literature and Spanish), Moi (literature and French), Mudimbe (literature), Surin (literature and Religion), Wiegman (literature and women’s studies); Associate Professors Donahue (German and literature), Lubiano (African and African American studies and literature), Mottahedeh (literature), Viego (literature and Spanish), Willis (literature); Assistant Professor Hadjioannou (literature); Research Professors Dorfman (literature and Latin American studies) Garreta (literature and French)

The interdepartmental 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, new media studies 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 500 series) and more specialized seminars (The 600-800 series), as well as tutorials (890s) in specific research projects or problems.

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. Students entering with a master's degree are expected to take a minimum of ten courses. More information on the program and a full descriptive brochure is available online at http://literature.aas.duke.edu/.

**Courses in Literature (LIT)**

510. Citizen Godard. 3 units. C-L: see French 510; also C-L: Arts of the Moving Image 642, Visual and Media Studies 552

515S. Interethnic Intimacies: Production and Consumption. 3 units. C-L: see Asian & Middle Eastern Studies 515S; also C-L: Arts of the Moving Image 515S, Visual and Media Studies 515S, International Comparative Studies 515S, Women's Studies 505S

520S. Performance Studies. 3 units. C-L: see Theater Studies 533S

521S. Historical and Philosophical Perspectives on Science. 3 units. C-L: see Philosophy 541S; also C-L: Women's Studies 541S, History 577S
530S. Seminar in Asian and Middle Eastern Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 505S; also C-L: African and African American Studies 540S

539S. Queer China. 3 units. C-L: see Asian & Middle Eastern Studies 539S; also C-L: Cultural Anthropology 539S, Women's Studies 502S, Arts of the Moving Image 539S, Visual and Media Studies 539S

540S. Methods and Theories of Romance Studies. 3 units. C-L: see Romance Studies 501S

541. Medieval Fictions. 3 units. C-L: see French 530; also C-L: Medieval and Renaissance Studies 642

541S. The Symbolist Movement in the Arts & European Thought. 3 units. C-L: see Art History 541S

542S. Literary Guide to Italy. 3 units. C-L: see Italian 586S; also C-L: German 586S, Arts of the Moving Image 640S

543S. Reading Heidegger. 3 units. C-L: see Asian & Middle Eastern Studies 540S; also C-L: Religion 560S

571. East Asian Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 605; also C-L: Cultural Anthropology 605, International Comparative Studies 605

572S. Antonio Gramsci and the Marxist Legacy. 3 units. C-L: see Italian 588S

573S. Ethnohistory of Latin America. 3 units. C-L: see Cultural Anthropology 570S; also C-L: History 540S

580S. Jews and the End of Theory. 3 units. C-L: see Asian & Middle Eastern Studies 541S; also C-L: Jewish Studies 541S, International Comparative Studies 541S

590. Special Topics in Literature. Special topics in Literature. Instructor: Staff. 3 units.

590S. Special Topics in Literature. Special topics in Literature. Instructor: Staff. 3 units.

610S. 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: Mottahedeh. 3 units. C-L: Arts of the Moving Image 610S

611S. 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: Mottahedeh. 3 units. C-L: Women's Studies 611S

612S. 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: Jameson, Mottahedeh, or staff. 3 units.

613S. Third Cinema. Exploration of the geopolitics of situatedness and distance as they refer to the film industry, investigating processes of production, distribution, and reception of Hollywood, Third World, and diasporic films, and studying classical and artisanal modes of production in film. Addresses questions of authorship and embodiment; human rights and interventionist filmmaking as they refer themselves to human states of liminality, global movements of populations and capital. Traces the experience of globalization, urbanization, alienation, violence, nostalgia for nature and homeland as represented in the filmic image. Instructor: Mottahedeh. 3 units. C-L: African and African American Studies 530S, International Comparative Studies 613S, Latin American Studies 613S, Arts of the Moving Image 644S

614S. Thinking Digital Cinema. Review of debates regarding digital cinema. Exploration of impact of new media technologies on contemporary cinema cultures. Examines question of medium specificity, cinema ontology, conventions of analog cinema vs. digital cinema, mediation/remediation/media convergence, applications of CGI, interactivity, cinephilia and DVD consumption, and spectatorship. Explores a series of philosophical questions surrounding our understanding and experience of contemporary cinema. Includes one trip to a local museum or gallery to examine

615S. The #Selfie. Focusing on digital self portraits that social media denizens have hashtagged "the selfie", the course will trace two different histories 1) the global history of portraiture in the arts and photography from the 19th C to the present 2) the emergence of the modern idea of "everyday life" (i.e. the routine, the trivial, the unconscious, the unremarkable) as the exact antithesis of what has routinely been called "history", all strongly associated with women and private life. These unrepresentable phenomenon have challenged notions of the state, Capital, urban design, and copyright, indeed the body and the Beautiful. Student driven case studies highlight everyday engagements with social media. Instructor: Mottahedeh. 3 units. C-L: Arts of the Moving Image 615S, Visual and Media Studies 615S, Women's Studies 615S, International Comparative Studies 615S

621S. Critical Studies in New Media. 3 units. C-L: see Visual and Media Studies 561S; also C-L: Art History 537S

622. Science Studies. 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 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. 3 units.

623. Body Works: Medicine, Technology, and the Body in Early Twenty-First Century America. 3 units. C-L: see Information Science and Information Studies 670; also C-L: Philosophy 570

624S. 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, Eisneman, 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 624S

625S. Comparative Media Studies. Explores the impact of media forms on content, style, form, dissemination, & reception of literary & theoretical texts. Assumes media forms are materially instantiated & investigates their specificities as important factors in their cultural work. Puts different media forms into dialogue, including print, digital, sonic, kinematic & visual texts, & analyzes them within a theoretically informed comparative context. Focuses on twentieth & twenty-first century theories, literatures, & texts, esp. those participating in media upheavals subject to rapid transformations. Purview incl. transmedia narratives, where different versions of connected narratives appear in multiple media forms. Instructor: Hayles. 3 units. C-L: Information Science and Information Studies 615S, Visual and Media Studies 625S

630S. Phenomenology and Media. Examination of phenomenology both as a philosophical movement and as a resource for contemporary media theory. Attention centers on the classical phase of phenomenology (from Husserl to Merleau-Ponty), on more recent developments in phenomenology and post-phenomenology (Levinas, Derrida, Fink, Barbaras), and on correlations between phenomenology and media theory (Ihde, Stiegler, Flusser). Key topics include: reduction, experience, time-consciousness, sensation, world manifestation, difference, reversibility, de-presencing, worldliness, readiness-to-hand and thrownness. Instructor: Hansen. 3 units. C-L: Art History 630S, Information Science and Information Studies 630S, Visual and Media Studies 630S, Arts of the Moving Image 631S

631S. Seminar on Modern Chinese Cinema. 3 units. C-L: see Asian & Middle Eastern Studies 631S; also C-L: Arts of the Moving Image 633S, Visual and Media Studies 631S

632. Modern Chinese Cinema. 3 units. C-L: see Asian & Middle Eastern Studies 631; also C-L: Arts of the Moving Image 632, Visual and Media Studies 632

632S. Whitehead, Bergson, James. An exploration of process philosophy, with particular attention to its relevance for contemporary issues in media, political economy, aesthetics, and culture. Focuses on three texts: Whitehead's Process and Reality, Bergson's Matter and Memory, and James's Essays in Radical Empiricism. Other works by these
philosophers and secondary literature on them will help establish context for arguments of these fundamental philosophical texts. Topics explored include: process, radical empiricism, vitalism, memory, perception, monism, experience, speculative empiricism, actuality & potentiality, the virtual, the fringe, the superject, causal efficacy, society, prehension, & selection. Instructor: Hansen. 3 units. C-L: Information Science and Information Studies 632S, Art History 632S, Visual and Media Studies 632S, Arts of the Moving Image 632S

640S. 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. 3 units. C-L: German 511S

644. 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.

672. 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.

681S. 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 582S, Philosophy 681S

682. 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.

683. Studies 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.

690. Special Topics in Literature. Topics vary by semester. Instructor: Staff. 3 units.

690-1. 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.

690-3. Topics in Cultural Studies. Instructors: Surin or staff. 3 units.

690-4. 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.

690-6. Topics in Psychoanalytic Criticism. Instructor: Moi or Viego. 3 units.

690-7. 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.

690-8. 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. Instructor: Jameson, Moi, Mudimbe, or Surin. 3 units.

690S. Special Topics in Literature. Topics vary each semester. Instructor: Staff. 3 units.

690S-3. Topics In Cultural Studies. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.
690S-4. Special Topics in Film. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

690S-8. 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 Literature 690-8. Instructor: Jameson or staff. 3 units.

695S. Literature Seminar. Contents and methods vary with instructors and from semester to semester. Instructor: staff. Variable credit.

735S. Space, Place, and Power. 3 units. C-L: see Cultural Anthropology 740S

740S. Early Modernism 1870-1914. 3 units. C-L: see English 810S

760S. Major Figures in Feminist Thought. 3 units. C-L: see Women's Studies 860S

761S. Foundations in Feminist Theory. 3 units. C-L: see Women's Studies 701S

770. Interdisciplinary Research Workshop. 3 units. C-L: see Women's Studies 770

780S. Teaching Race, Teaching Gender. 3 units. C-L: see African and African American Studies 780S; also C-L: Women's Studies 780S, History 780S

801. 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.

831. 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.

840S. 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.

880S. 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.

881S. 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, theater and the arts. Instructor: Moi. 3 units.

882S. Philosophy and Literature. 3 units. C-L: see Philosophy 947S

890. Special Topics in Literature. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

890S. Seminars in Literature. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

890T. Tutorial in Special Topics. Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

891. Special Readings. Consent of instructor required. Instructor: Staff. Variable credit.

892S. Publication Workshop. This course is a writing intensive, works-in-progress seminar for doctoral students interested in preparing an article for publication. It will explore the everyday challenges of writing and introduce students to the professional practices and protocols of journal publication. During the term, you will read and comment on the work of your peers, learn how to interpret and generate feedback in the form of "reader's reports," revise and present your own essay, and explore potential publication venues. The final act of the course will entail submitting your essay for publication in the journal of your choice. Instructor: Wiegman. 3 units. C-L: Women's Studies 892S
Marine Science and Conservation

Professor Chow, Chair; Professor Lubiano, 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), Mignolo (literature and Spanish), Moi (literature and French), Mudimbe (literature), Surin (literature and Religion), Wiegman (literature and women’s studies); Associate Professors Donahue (German and literature), Lubiano (African and African American studies and literature), Mottahedeh (literature), Viego (literature and Spanish), Willis (literature); Assistant Professor Hadjiioannou (literature); Research Professors Dorfman (literature and Latin American studies) Garreta (literature and French).

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 policymaking. 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 visit http://www.nicholas.duke.edu/marinelab/programs/graduate.

See the Marine Laboratory website for the current schedule of courses.

Track 1: Marine Biology
• Environment 849A (Graduate Seminar and Professional Development)
• Environment 878A (Current Topics in Marine Science)
• Environment 876A (Data and Time-series Analysis in Marine Sciences)

Track 2: Marine Conservation Biology and Policy
• Environment 849A (Graduate Seminar and Professional Development)
• Environment 878A (Current topics in Marine Conservation)
• Environment 887A (Political Ecology; or
• Environment 860SA (Theories and methods of policy analysis for the commons or approved substitute)

Master of Arts in Teaching Program

Alan B. Teasley, 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 graduate course credits, consisting of 15 course credits (five courses) within the student’s discipline, 9 course credits (three courses) of MAT-specific education courses, 2 course credits (one course) devoted to developing technology skills and 10 course credits 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, NC 27708-0093, or online at http://www.duke.edu/web/MAT/ or by e-mail at MAT-Program@duke.edu.

Courses in the Master of Arts in Teaching (MAT)

702. 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.

703. 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: Teasley. 3 units.

741S. 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: Staff. 5 units.

742S. 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. 5 units.

743S. 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: Master of Arts in Teaching 741S. Instructor: Staff. 2 units.

744S. Teaching Diverse Learners. Continuation of Master of Arts in Teaching 743S 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: Master of Arts in Teaching 742S. Open only to MAT students. Instructor: Staff. 1 unit.

791. 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 Arts

Professor Rankin, 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 fifteen courses over four semesters: ten required courses in prescribed sequence and five elective courses. In order to build cohesion in the program, all matriculating students will enroll concurrently in required courses in the first semester: two studio courses — MFA in Experimental and Documentary Arts 711 (Documentary Fieldwork) and MFA in Experimental and Documentary Arts 713 (Computational Media) — and one elective. In the second semester, the cohort will enroll in one required studio course — MFA in Experimental and Documentary Arts 712 (Experiments in the Moving Image) — one seminar — MFA in Experimental and Documentary Arts 703 (Continuity and Change in Experimental and Documentary Arts), — and one elective. After a summer of individual thesis research, the second year will focus on supporting production of the thesis project and paper via an elective methods seminar, a thesis production studio course, a seminar on research and writing the thesis, as well as two elective courses. All students are required to enroll in MFA in Experimental and Documentary Arts 720-723 (Critique I-IV) — to review, and discuss student work — in all four semesters. Final 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.

Courses in Experimental and Documentary Arts (MFAEDA)

703. Continuity and Change in Experimental and Documentary Arts. Explores the historical and conceptual construction of experimental and documentary arts with specific attention to experimental and artistic practices that have expanded influenced and expanded traditions of artistic expression. An introduction to a range of documentary expression from photography to writing, from film to installations, all based on documentary fieldwork alongside readings by experimental makers as well as related secondary and tertiary literature from diverse disciplines. Final paper/project required. Instructors: Rankin, Thompson, or Lenoir. 3 units.
711. Documentary Fieldwork. Semester-long individual documentary project using one or more documentary mediums, including photography, film/video, audio, and long form writing, or a blend of the above, with Durham and the Piedmont of North Carolina as our suggested focus. Experimentation with collaborative approaches to documentary fieldwork as well as individually driven work in documentary art. Requires final documentary project expressing cultural and political realities through a personal point of view. Instructor: Harris, Thompson, or Rankin. 3 units.

712. Experiments in the Moving Image. Poetic and experimental image-making, utilizing techniques that trace a historical trajectory from celluloid to digital. Exploration of cinematographic principles and cameraless experiments. Readings and screenings focusing on avant-garde film and digital traditions supplement student productions. Team-taught. Instructor: Gatten. 3 units.

713. Computational Media Studio. Introduction to computer programming and interactive media production as artistic practice. In-depth exploration of critical possibilities opened by computational media through exercises, projects, and critiques. Experience with programming basics includes procedural and object-oriented programming, two- and three-dimensional graphics, data visualization, and innovative methods for interactivity. Team-taught. No previous programming experience required. Instructor: Olson. 3 units. C-L: Visual and Media Studies 713

720. MFAEDA Workshop and Critique I. A class that meets weekly for 3 hours to review, discuss and reflect on student work in-depth. Works critiqued will be both works-in-progress as well as finished projects. Guest scholars and visiting artists will join the class at times, bringing an "outside" perspective to discussions. Students will also be assigned formal roles to lead weekly critiques. Instructor: Staff. 1 unit.

721. MFAEDA Workshop and Critique II. A class that meets weekly for 3 hours to review, discuss and reflect on student work in-depth. Works critiqued will be both works-in-progress as well as finished projects. Guest scholars and visiting artists will join the class at times, bringing an "outside" perspective to discussions. Students will also be assigned formal roles to lead weekly critiques. Instructor: Staff. 1 unit.

722. MFAEDA Workshop and Critique III. A class that meets weekly for 3 hours to review, discuss and reflect on student work in-depth. Works critiqued will be both works-in-progress as well as finished projects. Guest scholars and visiting artists will join the class at times, bringing an "outside" perspective to discussions. Students will also be assigned formal roles to lead weekly critiques. Instructor: Staff. 1 unit.

723. MFAEDA Workshop and Critique IV. A class that meets weekly for 3 hours to review, discuss and reflect on student work in-depth. Works critiqued will be both works-in-progress as well as finished projects. Guest scholars and visiting artists will join the class at times, bringing an "outside" perspective to discussions. Students will also be assigned formal roles to lead weekly critiques. Instructor: Staff. 1 unit.

791. Thesis Writing Workshop. Support for the writing of the thesis paper through multiple drafts and group discussion. Writing of a concise critique of the MFAEDA project following its completion and exhibition. Instructor: Abe. 3 units.


Mathematics
Professor H. Layton, Chair (113 Physics); Professor Durrett, Director of Graduate Studies (117 Physics); Professors Agarwal, Aspinwall, Beale, H. Bray, Calderbank, Daubechies, Durrett, Hain, Harer, H. Layton, Liu, Maggioni, Mattingly, Miller, Pardon, Petters, Reed, Rose, Saper, Schaeffer, Schoen, Stern, Venakides, Witelski; Associate Professors Kraines, Ng, Plesser; Assistant Professors Getz, A. Layton, Lu, Mukherjee, Nolen, Pierce; Professors Emeriti Allard, Kitchen, Hodel, Moore, Smith, Trangenstein, Warner, Weisfeld and Zhou; Adjunct Professor Wahl

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 course credits of graded coursework 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 website at http://www.math.duke.edu/. For inquiries, e-mail the director of graduate studies at dgs-math@math.duke.edu.

Courses in Mathematics (MATH)
129. Calculus for social science research. Calculus for graduate students in the social sciences. Topics include transcendental functions, limits, differentiation, integration, the fundamental theorems, continuous probability distributions, infinite series, Taylor's theorem. Not open to undergraduates. Instructor consent required. Instructor: Bookman. 3 units.
501. 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 401. Prerequisite: Mathematics 221 or equivalent. Instructor: Staff. 3 units.
502. Introduction to Algebraic Structures II. Fields and field extensions, modules over rings, further topics in groups, rings, fields, and their applications. Prerequisite: Mathematics 501, or 401 and consent of instructor. Instructor: Staff. 3 units.
527. General Relativity. 3 units. C-L: see Physics 622
531. Basic Analysis I. Topology of R^n, continuous functions, uniform convergence, compactness, infinite series, theory of differentiation, and integration. Not open to students who have had Mathematics 431. Prerequisite: Mathematics 221. Instructor: Staff. 3 units.
532. Basic Analysis II. Differential and integral calculus in R^n. Inverse and implicit function theorems. Further topics in multivariable analysis. Prerequisite: Mathematics 221; Mathematics 531, or 431 and consent of instructor. Instructor: Staff. 3 units.
545. 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. Functionals 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 431) and probability (Mathematics 230 or 340). Instructor: Staff. 3 units.

555. **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 221, 216 or 356, and 531 or 431. Instructor: Staff. 3 units.

557. **Introduction to Partial Differential Equations.** Fundamental solutions of linear partial differential equations, hyperbolic equations, characteristics, Cauchy-Kowalevski theorem, propagation of singularities. Prerequisite: Mathematics 532 or equivalent. Instructor: Staff. 3 units.

561. **Scientific Computing.** Structured scientific programming in C/C++ and FORTRAN. Floating point arithmetic and interactive graphics for data visualization. Numerical linear algebra, direct and iterative methods for solving linear systems, matrix factorizations, least squares problems and eigenvalue problems. Iterative methods for nonlinear equations and nonlinear systems, Newton's method. Prerequisite: Mathematics 212 and 221. Instructor: Staff. 3 units.


565. **Numerical Analysis.** 3 units. C-L: see Computer Science 520; also C-L: Statistical Science 612

573S. **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 Modeling Biological Systems 495S. Prerequisites: Mathematics 216 or 356 or consent of instructor. 3 units. C-L: Modeling Biological Systems 573S, Computational Biology and Bioinformatics 573S

575. **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 453 or 551 or an equivalent course. Instructor: Staff. 3 units.

577. **Mathematical Modeling.** Formulation and analysis of mathematical models describing problems from science and engineering including areas like biological systems, chemical reactions, and mechanical systems. Mathematical techniques such as nondimensionalization, perturbation analysis, and special solutions will be introduced to simplify the models and yield insight into the underlying problems. Instructor: Staff. 3 units.

581. **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 212 (or 222), 221, and 230 (or 340), or consent of instructor. Instructor: Staff. 3 units. C-L: Economics 673

582. **Financial Derivatives.** A rigorous introduction to financial derivatives with applications. Topics include: binomial trees and geometric Brownian motion; European options, American options, forwards, and futures; put-call parity; the Black-Scholes-Merton pricing formula and its derivations; Delta and Gamma hedging; implied volatility; Merton jump-diffusion model; Heston model; GARCH(1,1) model. Prerequisites: Math 212 (or 222) and Math 230 (or 340) or consent of instructor. Instructor: Staff. 3 units. C-L: Economics 674

590-01. **Special Readings.** Instructor: Staff. 3 units.

601. **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 502 or equivalent. Instructor: Staff. 3 units.
602. An Introduction to Commutative Algebra and Algebraic Geometry. Affine algebraic varieties, Groebner bases, localization, chain conditions, dimension theory, singularities, completions. Prerequisite: Mathematics 601 or equivalent. Instructor: Staff. 3 units.

603. 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 501 or equivalent. Instructor: Staff. 3 units. C-L: Physics 603

605. 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 502 or 601 or consent of instructor. Instructor: Staff. 3 units.

607. 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 601 or consent of instructor. Instructor: Staff. 3 units.

611. 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 411 and 501 or consent of instructor. Instructor: Staff. 3 units.

612. 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 611 or consent of instructor. Instructor: Staff. 3 units.

619. Computational Topology. 3 units. C-L: see Computer Science 636

621. 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 532 or equivalent. Instructor: Staff. 3 units.

625. 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 633 and Mathematics 611 or consent of instructor. Instructor: Staff. 3 units.

627. Algebraic Geometry. Projective varieties, morphisms, rational maps, sheaves, divisors, sheaf cohomology, resolution of singularities. Prerequisite: Mathematics 602 and 625; or consent of instructor advised. Instructor: Staff. 3 units.

631. Real Analysis. Real Analysis. Lebesgue measure and integration; L^p spaces; absolute continuity; abstract measure theory; Radon-Nikodym Theorem; connection with probability; Fourier series and integrals. Instructor: Staff. 3 units.

633. Complex Analysis. Complex calculus, conformal mapping, Riemann mapping theorem, Riemann surfaces. Prerequisite: Mathematics 532 or equivalent. Instructor: Staff. 3 units.

635. Functional Analysis. Metric spaces, fixed point theorems, Baire category theorem, Banach spaces, fundamental theorems of functional analysis, Fourier transform. Prerequisite: Mathematics 631 or equivalent. Instructor: Staff. 3 units.

641. 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 631 or Statistical Science 711 or equivalent. Instructor: Staff. 3 units.

651. Hyperbolic Partial Differential Equations. Linear wave motion, dispersion, stationary phase, foundations of continuum mechanics, characteristics, linear hyperbolic systems, and nonlinear conservation laws. Prerequisite: Mathematics 557 or equivalent. Instructor: Staff. 3 units.


690-00. 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 627 or consent of instructor. Instructor: Staff. 3 units.

690-05. Topics in Number Theory. A selection of topics from algebraic number theory, arithmetic geometry, automorphic forms, analytic number theory, etc. Instructor: Staff. 3 units.

690-10. Topics in Topology. Algebraic, geometric, or differential topology. Consent of instructor required. Instructor: Staff. 3 units.

690-20. 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 621 or consent of instructor. Instructor: Staff. 3 units.

690-30. Topics in Complex Analysis. Geometric function theory, function algebras, several complex variables, uniformization, or analytic number theory. Prerequisite: Mathematics 633 or equivalent. Instructor: Staff. 3 units.

690-32. Topics in Analysis. Topics in analysis geared towards topics of current research interest. The prerequisites will depend on the specific topic covered. Instructor: Staff. 3 units.

690-40. 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 230 or 340 or equivalent, and consent of instructor. Instructor: Staff. 3 units. C-L: Statistical Science 690-40

690-50. Topics in Partial Differential Equations. Hyperbolic conservation laws, pseudo-differential operators, variational inequalities, theoretical continuum mechanics. Prerequisite: Mathematics 651 or equivalent. Instructor: Staff. 3 units.

690-82. Topics in Mathematical Finance. Topics of current research interest in mathematical models with relevant applications to finance. Prerequisites: Mathematics 230 or 340 or equivalent, or consent of instructor. Possible additional prerequisites depending on course content. Instructor: Staff. 3 units. C-L: Economics 690-82

743. Linear Models. 3 units. C-L: see Statistical Science 721

771S. 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.

790-01. Current Research in Algebra. Not open to students who have taken Mathematics 790-10 and 790-20. Instructor: Staff. 3 units.

790-03. Research in Algebraic Geometry. Mini seminars on current topics which are repeatable for credit. Instructor: Staff. 1 unit.

790-10. Current Research in Topology. Not open to students who have taken Mathematics 790-03 and 790-73. Instructor: Staff. 3 units.


790-30. Current Research in Analysis. Not open to students who have taken Mathematics 790-50 and 790-71. Instructor: Staff. 3 units.

790-50. Research in Differential Equations. Mini seminars on current topics which are repeatable for credit. Instructor: Staff. 1 unit.


790-73. Current Research in Mathematical Physics. Not open to students who have taken Mathematics 790-77. Instructor: Staff. 3 units.

790-77. Current Research in Mathematical Biology. This course will consist of three minicourses, each of which presents current research in an area of mathematical biology. Different topics will be covered in different years and students may re-take the course. Topics will be drawn from: probability theory and genomics, mathematical methods in biochemistry and cell biology, applications of topology and geometry to genomics and protein folding, heart physiology and mathematical issues in cardiac arrhythmias, biofluid mechanics, mathematical methods in kidney function, mathematical questions in image reconstruction, analysis of large data sets, and the evolution of viruses. 1 unit.

790-90. Minicourse in Advanced Topics. Mini seminars on current topics which are repeatable for credit. Instructor: Staff. 1 unit.

Medical Physics

Associate Professor Dobbs, Director; Associate Professor Turkington, Director of Graduate Studies; Professors Das, Dewhirst, Frush, Howell, Izatt, Johnson, MacFall, Oldham, Provenzale, Samei, Smith, Allen Song, Spicer, Trahey, Vaidyanathan, Jackie Wu, Qiuwen Wu, Ying K. Wu, Yin, Zalutsky, Yoshizumi; Associate Professors Badea, Bida, Charles, Chen, Chin, Craciunescu, Driehuys, Dobbins, Kirkpatrick, Lo, Segars, Tornai, Turkington, Wang, Wax, Yoo; Assistant Professors Adamson, Bowsher, Cai, Chang, Kapadia, Liu, Mazurowski, O'Daniel, Petry, Reiman, Ren, Haijun Song, Truong, Yan; Accelerator Health Physicist Gunasingha.

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.
Courses in Medical Physics (MEDPHY)

500. 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 dosimetry. Consent of instructor required. Instructor: Gunasingha. 3 units.

505. 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., Pneumothrax in chest radiographs, microcalcifications in mammograms). Consent of instructor required. Instructor: Reiman. 3 units.

507. Radiation Biology. An introduction to radiation biology. This course will cover the biological effects of radiation, including mechanisms of DNA damage, and normal tissue injury. The principle context is with relevance to radiation therapy treatment. Instructor consent required. Instructor: Oldham, Dewhirst. 1 unit.

510. 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.

520. 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.

530A. 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.

541. 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.

714. 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: Medical Physics 500 and 505. Instructor: Yoshizumi. Variable credit.

715. 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: Medical Physics 500 and 505. Instructor: Gunasingha. 1 unit.

718. 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 preparation experience under NRC/States oversight. The course includes shadowing a clinician, technologist, or physicist, while performing their routine clinical tasks. Instructor: Yoshizumi. 3 units.

722. 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: Medical Physics 520. Instructor: Das. 3 units.
723. Advanced Brachotherapy/Special Topics and Procedures. This course covers advanced LDR and HDR brachytherapy, and other selected special topics and procedures. Instructor consent required. Instructors: Yin, Craciunescu, Jackie Wu, Qiuwen Wu, Zh. Chang. 1 unit.

726. 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. Instructors: Gunasingha, H. Song, A. Kapadia. Variable credit.

727. 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 520 and 722 (or Medical Physics 722 concurrently). Instructor: Kirkpatrick. 1 unit.

728. 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: Wang, Craciunescu, Yoo, Zh. Chang, Ren, Steffey. 3 units.

729. 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 medical physicist. Instructor: Yin. 10 units.

731. 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: Medical Physics 530A. Consent of instructor required. Instructors: Dobbins, Badea, Bida, Liu. 3 units.

738. Radiology in Practice. 3 units. C-L: see Biomedical Engineering 848L

743. 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, and the MIRD methodology. Strategies to convert small animal radiopharmaceutical biodistribution data to humans will also be covered. Prerequisites: Medical Physics 500 and 505. Instructor: Reiman. 1 unit.

744. PET and SPECT Image Reconstruction and Analysis. This course will cover the basics of image reconstruction for tomographic imaging in nuclear medicine. Filtered backprojection and iterative methods will be explored, including methods for correcting physical effects such as attenuation and scatter. Basic concepts of image quality and quantitative use of PET and SPECT image will be introduced. Prerequisite: Medical Physics 541. Instructor: Turkington. 1 unit.

746. Radiopharmaceutical Chemistry. The course will cover radiochemistry and production of various radiopharmaceuticals. The course will be conducted with lecture but may include some practical demonstrations. Prerequisite: Medical Physics 500 and 505. Instructor: Vaidyanathan. 1 unit.

748. 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: Turkington. 3 units.
751. **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: Kapadia, Oldham, Segars. 1 unit.

761. **Fundamentals of Biostatistics.** 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 4-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 4-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 5-week session. 1 course credit each session. Repeatable for 3 total credits. Instructors: Kapadia, Mazurowski. 1 unit.

770. **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 physicist, nonetheless, need to have knowledge of. Topics include genomics, bioinformatics, proteomics, and others. Instructor: Colsher, Tornai. 3 units.

791. **Independent Study in Medical Physics.** An independent research project with faculty advisor. Consent of instructor required. Instructor: Staff. Variable credit.

792. **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: Biomedical Engineering 333/Medical Physics 530A or equivalent. Instructor: Samei. 3 units.

**Medical Scientist Training Program**

Christopher D. Kontos, MD, Director

The Medical Scientist Training Program (MSTP), 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 trainee’s chosen field of study with the clinical curriculum of the School of Medicine. Most trainees pursue a PhD degree in the biomedical sciences but others pursue degrees in medically relevant social sciences. Completion of the program typically requires seven to eight years of study and leads to both the MD and PhD degrees. The combination of scientific 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. Application and acceptance to the School of Medicine is requisite for admission to the MSTP. Most students apply for admission to the MSTP concurrent with application to first year of the MD program, but a few students are admitted each year after completing the second or third year of the School of Medicine. In addition to the minimum requirements for acceptance into The Graduate School and the School of Medicine, advanced coursework 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 US citizens or official permanent residents of the United States.

**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 2014-2015 is $29,420 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, NC 27710; (919) 668-5528; MSTP@duke.edu.

Middle East Studies
Kelly Jarrett, PhD, Associate Director (124 Franklin Center)

A certificate is available in this program.

The Middle East studies certificate trains students for interdisciplinary research in Middle East studies and is designed to complement the disciplinary training in their home departments. The certificate is open to students in any department or professional school at Duke University who are engaged with the study of the Middle East. The certificate will be a joint offering of the Consortium in Middle East Studies through the Department of Asian and Middle East Studies at Duke and the Department of Religious Studies at UNC-Chapel Hill.

The objectives of this graduate certificate are to offer a coherent set of courses that introduce Middle East studies as an interdisciplinary field to MA, professional students, and PhD students; link coursework to research, doctoral exams, and thesis or dissertation writing, with an emphasis on the challenges of blending disciplinary and interdisciplinary training; and to provide training for classroom instruction in Middle East studies through coursework, faculty mentorship programs, and opportunities for teaching. The graduate certificate is built around an interdisciplinary core course and a research workshop that are both cotaught by faculty from two departments (one each from Duke and UNC).

Graduate Certificate Requirements:

- Complete the Certificate Core Course: Asian and Middle Eastern Studies 620S-01 (Critical Genealogies of the Middle East: An examination of the canon of Middle East scholarship). This course provides an in-depth investigation into the various theoretical and textual traditions that inform interdisciplinary Middle East studies with a focus on history, cultural studies, religion, and social sciences. Interdisciplinary in scope, the course will maintain a disciplinary rigor so that students learn how knowledge is produced within the framework of specific disciplines. Foci include social history, literary theory, critical visual studies, and postcolonial theory. The course goals are
  - to acquaint students with the history and current state of Middle East studies;
  - to prepare students for undergraduate teaching in Middle East studies;
  - to build a cohort of graduate students with intellectual and personal ties across disciplines; and
• to push students forward on their own research agendas.

• Complete three additional graduate courses on a topic related to the Middle East. One course must be outside the student’s home department or school. Of these three courses one may be an advanced Middle East language (third-year and above in Arabic, Hebrew, Persian, Turkish, or Urdu). In order to count a course toward the certificate, students must demonstrate to the certificate program director that comparative and theoretical courses contain at least 50 percent Middle East content.

• Participate in a biweekly workshop organized each spring by the Consortium in Middle East Studies. This workshop is tailored to the interests of enrolled students who suggest readings for discussion and present their own work. There is no grade or credit associated with this workshop. To enroll, contact the Consortium in Middle East Studies prior to the beginning of the spring workshop. As an example, the 2011 workshop allowed students and faculty the opportunity to present drafts of papers and thesis proposals and discussed the following subjects:
  • how to present papers at conferences;
  • how to craft literature reviews;
  • how to prepare and submit articles for publication;
  • how to prepare book proposals;
  • how to speak to the media; and
  • how to write research and grant proposals.

• Submit to the Consortium in Middle East Studies a thesis, dissertation chapter, or a major seminar research paper on a topic related to Middle East studies. Students can meet this requirement through completion of one of the requirements for the student’s primary degree (usually a master’s thesis or PhD dissertation chapter). Students who are in programs that do not require a master’s thesis must submit an equivalent research project (usually a major seminar paper) that is appropriate to their discipline. A member of the Faculty Steering Committee will read the written research work to judge whether it is suitable to complete the research requirement of the certificate, or, if appropriate, request that a Duke or UNC faculty member who specializes in the research area covered by the work make this judgment. It may be selected for posting online.

• Demonstrate relevant language skills, or international experience, or training. Language competency in a Middle Eastern language (Arabic, Modern Hebrew, Persian, Turkish, or Urdu) may be demonstrated by taking a placement test or an advanced language class or by using primary language texts in the major research project. International experience and training should include research, fieldwork, or study in a Middle Eastern country.

• Evaluation. Students who have completed the program will fill out an exit survey and be interviewed by one of the program codirectors. This interview will provide us with an understanding of the extent to which the student has mastered some of the key issues in Middle Eastern studies and allow us to evaluate the extent to which the academic outcome goals of the program are being met. We will also track the future activities of students to determine the impact of this program on their professional development. The codirectors for the program will meet once a year to discuss the results of the exit surveys and interviews to determine if the program will need to be changed to better meet the needs of the students.

The Duke University Middle East Studies Center, together with UNC’s Carolina Center for the Study of the Middle East and Muslim Civilizations, form the Duke-UNC Consortium in Middle East Studies. In addition to the graduate certificate, the Duke-UNC Consortium cosponsors many special events, conferences, and opportunities for students, scholars, and faculty to interact and collaborate. The interdisciplinary focus of the graduate certificate program is enhanced by the consortium’s many activities which offer graduate students a variety of intellectually challenging opportunities to enhance their academic training. In addition, the Duke-UNC Consortium awards several Foreign Language and Area Studies (FLAS) Fellowships each spring and been designated a National Resource Center for Middle East Studies by the US Department of Education.

For more information about the graduate certificate in Middle East studies and DUMESC’s other activities, please go to DUMESC’s website at http://middleeaststudies.duke.edu/ or contact the program coordinator, Box 90402, Duke University, Durham, NC 27708; (919) 668-1653; mideast@duke.edu.

Molecular Biophysics, University Program in

See “Structural Biology and Biophysics” on page 321.
Molecular Cancer Biology

Professor Wang, Director (C218 LSRC); Professor Pendergast, Director of Graduate Studies (C233 LSRC); Professors Andrews (pediatrics), Bennett (cell biology), Blobe (medicine), Cardenas-Corona (molecular genetics and microbiology), Caron (cell biology), Casey (pharmacology and cancer biology), Counter (pharmacology and cancer biology), Dewhirst (radiation oncology), Diehl (medicine), Garcia-Blanco (molecular genetics and microbiology), Heitman (molecular genetics and microbiology), Kastan (pharmacology and cancer biology), Keene (molecular genetics and microbiology), Kornbluth (pharmacology and cancer biology), Lefkowitz (medicine), Lew (pharmacology and cancer biology), Li (Dermatology), Lyerly (surgery), McDonnell (pharmacology and cancer biology), Patz (radiology), Pendergast (pharmacology and cancer biology), Petes (molecular genetics and microbiology), Sampson (surgery), Stripp (medicine), Thiele (pharmacology and cancer biology), Wang (pharmacology and cancer biology), Yan (pathology), Yao (pharmacology and cancer biology) and Zhuang (Immunology); Associate Professors Chi (molecular genetics and microbiology), Gromeier (surgery), Hurwitz (medicine), Kontos (medicine), Linardic (pediatrics), MacAlpine (pharmacology and cancer biology), Murphy (gynecology oncology), Rathmell (pharmacology and cancer biology), Rizzieri (medicine), Spector (medicine), and Yang (medicine); Assistant Professors Fox (pharmacology and cancer biology), Hirschev (medicine), Hsu (medicine), and Wood (pharmacology and cancer biology)

The molecular cancer biologists at Duke University seek 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 anticancer 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 cellularly 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 eleven 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.

Courses in Molecular Cancer Biology (MOLCAN)

691. Independent Study in Molecular Cancer Biology. Consent of instructor required. Instructor: Staff. 1 unit.

730. Stem Cell Course. 3 units. C-L: see Cell Biology 730; also C-L: Pharmacology and Cancer Biology 730

760. Cellular Signaling. 3 units. C-L: see Cell Biology 760; also C-L: Biochemistry 760, Pharmacology and Cancer Biology 760

780. Graduate Student Seminar. A presentation and discussion course in which program faculty and graduate students review recent progress in contemporary areas of Pharmacology and Cancer Biology. Provides an important avenue for evaluation and feedback for graduate student research and communication skills and is required for all students pursuing their Ph.D. degree in Pharmacology and Molecular Cancer Biology. Instructor: Thiele/Wang. 2 units.

818. Molecular Mechanisms of Oncogenesis. Lectures and oral presentations in the field of molecular biology of cancer. At the end of the semester students write and orally defend a grant on a topic in cancer biology. Instructor consent required. Prerequisite: Cell Biology 760. Instructors: Counter and Yao. 2 units. C-L: Pharmacology and Cancer Biology 818

819. Cancer as a Disease. Instructor: Mathey-Prevot. 2 units.

Molecular Genetics and Microbiology

Professor Heitman, Chair (322 CARL); Assistant Professor Micah Luftig, Director of Graduate Studies (424 CARL); Professors Cullen, Garcia-Blanco, Goldstein, Heitman, Jinks-Roberson, Keene, Linney, Marchuk, Nevins, Petes, and Willard; Associate Professors Aballay, Chi, Dietrich, Matsunami, McCusker, Mitchell, Pickup, Rawls, Sullivan, Valdivia; Assistant Professors Coers, David, Horner, Ko, Luftig, Silver, Tobin, Yan
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 coursework, 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. Visit http://mgm.duke.edu for more information.

Courses in Molecular Genetics & Microbiology (MGM)

522. Critical Readings in Genetics and Genomics. 3 units. C-L: University Program in Genetics 522

532. 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 778 or equivalent, and graduate status or consent of instructor. Instructors: Marchuk and staff. 3 units. C-L: University Program in Genetics 532

552. 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.

582. 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: Tobin and staff. 3 units.

593. Research Independent Study. Independent research in Molecular Genetics and Microbiology. Instructor: Staff. 3 units.


702. 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: Marchuk. 3 units. C-L: University Program in Genetics 702

703. Advanced Topics in Infection Biology. This course is a literature based course taught by 3-4 faculty on emerging topics of importance in the field of host-pathogen interactions. The class size will be limited to approximately 6. Class meets two times per week. Instructor: Coers and staff. 3 units.

778. Genetic Approaches to the Solution of Biological Problems. 4 units. C-L: see University Program in Genetics 778; also C-L: Cell and Molecular Biology 778, Biology 728

790S. Topics in Molecular Genetics and Microbiology. Required course for all graduate students receiving their degree through MGM. Instructor: Luftig and staff. 1 unit.

Music

Professor Hawkins, Chair; Associate Professor Waebber, Director of Graduate Studies; Professors Berliner, Brothers, Gilliam, Jaffe, Lindroth, Todd; Associate Professors McCarthy, Meintjes, Rupprecht; Assistant Professors Supko; Professor of the Practice Parkins

The Department of Music offers graduate programs leading to the PhD degrees in composition and musicology. 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 “Interdisciplinary Medieval and Renaissance Studies” on page 211). For students pursuing the musicology PhD with emphasis in performance practice, 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, seventeen courses (51 course credits) are required; no more than three courses (9 course credits) 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 coursework, 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, seventeen courses (51 course credits) are required; no more than three courses (9 course credits) 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 coursework, 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, eleven courses (33 course credits) 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. The MA in performance practice is not a terminal degree; it is granted only to candidates matriculated into the PhD in musicology.

A more detailed description of each degree program is available upon request from the director of graduate studies.

Courses in Music (MUSIC)

501. 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.

511-1. 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.

551. Music in the Middle Ages. Selected topics. Instructor: Brothers. 3 units. C-L: Medieval and Renaissance Studies 522

552. Topics in Renaissance Music. Selected topics. Instructor: Brothers or McCarthy. 3 units. C-L: Medieval and Renaissance Studies 523


554. Music in the Classic Era. Selected topics. Instructor: Todd. 3 units.

555. Music in the Nineteenth Century. Selected topics. Instructor: Gilliam or Todd. 3 units.

556. Music in the Twentieth Century. Selected topics. Instructor: Brothers, Gilliam, or Todd. 3 units.

560. Tonal Analysis. In-depth study of various methods for analyzing tonal music. Approach and content vary by instructor. Instructor: Staff. 3 units.

561S. 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, trouvére monophony, Machaut, Fifteenth-century polyphony, modal music of the Renaissance, early seventeenth-century repertories. Instructors: Brothers or McCarthy. 3 units.

575S. Generative Media Authorship - Music, Text & Image. Covers Generative Media in all its forms. Lectures, workshops, discussions, one semester-length project, shorter individual exercises and readings. Interdisciplinary Graduate Seminar with advanced undergraduates and MFA students with permission of instructor. Instructor: Seaman and Supko. 3 units. C-L: Visual and Media Studies 575S, Arts of the Moving Image 575S, Information Science and Information Studies 575S
590. 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 560 or consent of instructor. Instructor: Rupprecht or staff. 3 units.

663. 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, Rupprecht, or Supko. 3 units.

690S-1. Composition Seminar: Selected Topics. Selected topics in composition. Instructor: Brothers, Jaffe, Lindroth, or Supko. 3 units.

697. 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.

698. Composition. Continuation of Music 697. 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.

699. Composition. Continuation of Music 698. 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.

718S. Seminar in Performance Practice. A practical seminar in which participants will be expected to perform, to introduce the work to be played or sung, and to outline its interpretative problems. A list of the music concerned will be posted in advance, and all students will participate in the study (if not necessarily in the performance) of the works announced. It is expected that the seminar will cover most periods, from Gregorian chant to twentieth-century repertoires. Consent of instructor required. Instructor: Staff. 3 units.

790S-1. Seminar in the History of Music. Selected topics. Instructor: Staff. 3 units.


791. 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.

792. 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.

797. Composition. Weekly independent studies at the doctoral level with a member of the graduate faculty in composition. Instructor: Jaffe, Lindroth, or Supko. 3 units.

798. Composition. Weekly independent studies at the doctoral level with a member of the graduate faculty in composition. Instructor: Jaffe, Lindroth, or Supko. 3 units.

799. 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
Professor Jie Liu, Director of Graduate Studies (3220 French Family Science Center)

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

Nanoscience 237
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 (1) synthesis of nanostructured materials, (2) fundamental properties of nanostructured materials, (3) nanodevice fabrication and applications, and (4) 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 School of Medicine. Member departments include biology, biochemistry, biomedical engineering, cell biology, chemistry, civil and environmental engineering, computer science, electrical and computer engineering, mechanical engineering and materials science, and physics.

For additional information, contact Professor Jie Liu (jie.liu@duke.edu) or Assistant to Director of Graduate Studies Caroline Morris (caroline.morris@duke.edu).

Requirements

Participating departments include biochemistry, biology, biomedical engineering, cellular biology, chemistry, civil and environmental engineering, computer science, electrical and computer engineering, mechanical engineering and materials science, and physics. 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).

Certificate requirements include

• participation in the Nanoscience Seminar Series and
• three elective courses (listed below).

For more information, visit http://nano.duke.edu/.

Course in Nanosciences (NANOSCI)

511. 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 152L and Chemistry 101DL or instructor approval. Instructor: Staff. 3 units. C-L: Electrical and Computer Engineering 511

Elective Courses in Nanoscience (Three required for certificate)

Biomedical Engineering
302. Fundamentals of Biomaterials and Biomechanics
436. Biophotonic Instrumentation
522. Introduction to Bionanotechnology Engineering
525. Biomedical Materials and Artificial Organs
567. Biosensors
590. Advanced Topics in Biomedical Engineering
850. Advances in Photonics: An Overview of State-of-the-Art Techniques and Applications

Chemistry
521. Inorganic Chemistry
523. Quantum Information Science
541. Quantum Chemistry
548. Solid-State and Materials Chemistry
601. Biosensors

Computer Science
555. Probability for Electrical and Computer Engineers
590-2. Molecular Assembly and Computation
663. Algorithms in Structural Biology and Biophysics
664. Computational Structural Biology

Electrical and Computer Engineering
545. Nanophotonics
611. Nanoscale and Molecule Scale Computing

Physics
607. Introduction to Condensed Matter Physics
627. Quantum Information Science
810. Advanced Solid State Physics
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 Alzheimer’s and Parkinson’s, and neurodevelopmental disorders such as autism.

Neurobiologists approach the questions of how the brain works with techniques that are diverse, and generally reductionist. Pre-eminent are a host of sophisticated imaging and electrophysiological methods for detecting the activity of individual nerve cells or groups of nerve cells, extremely novel applications of the techniques of molecular biology and molecular genetics, and a wealth of anatomical methods for seeing the structure and connections of nerve cells. Noninvasive means of recording activity in the human 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. Still, progress in neurobiology—much as progress in any science—will depend on 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. The Graduate Training Program has its home in the Department of Neurobiology at Duke University Medical Center, and includes forty-two training faculty with primary appointments in thirteen different departments in the School of Medicine, the Trinity College of Arts & Sciences, and the Pratt School of Engineering. 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 Neurobiology 751 (Neuroscience Bootcamp), Neurobiology 790 (Student Seminar), Neurobiology 719 (Concepts in Neuroscience I), Neurobiology 720 (Concepts in Neuroscience II), Neurobiology 762 (Neurobiology of Disease), and Neurobiology 726 (Neurobiology Journal Club).

For additional information, visit [http://www.neuro.duke.edu/](http://www.neuro.duke.edu/) or e-mail peloquin@neuro.duke.edu.

**Courses in Neurobiology (NEUROBIO)**

559. **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 559, Psychology 580

702. **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.

719. **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.

720. 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: Neurobiology 702 and Neurobiology 719. Consent of instructor is required. Instructor: Mooney. 3 units.


720B. Concepts in Neuroscience II - Learning and Memory. This module concerns the neural basis of learning and memory, with emphasis on bird song and decision making in drosophila. Instructor: Groh/Franks. 1 unit.

720C. Concepts in Neuroscience II - Sensory/Motor Integration. This module concerns how sensory and motor structures of the brain communicate with each other to support movements guided by sensory stimuli. Instructor: Groh. 1 unit.


720E. Concepts in Neuroscience II - Sensory Perception & Cognition. This module concerns the neural basis of sensory processing and its connection to cognition. Instructor: Lisberger/Sommer. 1 unit.

726S. 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.

733. Experimental Design and Biostatistics for Basic Biomedical Scientists. 2 units. C-L: see Pharmacology and Cancer Biology 733; also C-L: Cell and Molecular Biology 733, Biomedical Engineering 733

751. Neuroscience Bootcamp. 2 units. C-L: see Neuroscience 751

755. Neurotoxicology. 3 units. C-L: see Pharmacology and Cancer Biology 755

759S. Principles in Cognitive Neuroscience I. 3 units. C-L: see Psychology 759S; also C-L: Philosophy 753S

760S. Principles in Cognitive Neuroscience II. 3 units. C-L: see Psychology 760S; also C-L: Philosophy 754S

761. Neuropharmacology: From Molecules to Behavior. 3 units. C-L: see Pharmacology and Cancer Biology 761

762. Neurobiology of Disease. Meeting 3x week — month of January - discuss given disease of the nervous system. One or two students working with a designated faculty member are responsible for an introduction (20-25 minutes) followed by a discussion of key primary papers on the subject. Two or three articles provided at least a week in advance provide a framework for discussion. Diseases to be covered currently include: ALS, Alzheimer's, CNS neoplasms, Epilepsy, multiple sclerosis, Parkinson's disease, retinitis pigmentosa, and stroke. will discuss key features of the disease, etiology and pathogenetic mechanisms of the disease, models available and the evidence establishing the validity of the models & therapies. Instructor: Staff. 2 units.

790S. Student Seminar (Topics). 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.


859. 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. 2 units.

881. 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: Adcock. 3 units.

C-L: Psychology 762

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 (aquatic 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 coursework.

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. Students must complete the following:

• Survey course (Nonlinear and Complex System 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/cnsc/courses.html.

Course in Nonlinear and Complex System (NCS)

501. Survey of Nonlinear and Complex Systems. 2 units. C-L: see Physics 501
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
- 305. 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
- 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
The PhD program in nursing will prepare nurse 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 coursework, (a) to ensure socialization to the role of research scientist; (b) ensure significant knowledge and skill acquisition for launching a successful program of independent research post doctorate; and (c) to prepare for an entry level role in an academic setting.
The program requires a minimum of 47 course credits of graduate coursework (post-MSN) prior to a dissertation. Post-BSN students are required to take an additional three-credit advanced practice role course. Students will work on active research projects, and it is expected that most will graduate with a record of publication. Coursework is structured with a substantial core (36 course credits) of nursing science and research methods to be taken in the Duke University School of Nursing. This core will be expanded with elected statistics, research methods, and minor area courses (9 course credits) to be taken mainly outside of nursing in other Duke University departments. Additional requirements include a 1-credit research practica, and a 1-credit teaching practicum. In addition, each student develops a scholarly portfolio. Each student completes a preliminary exam (admission to PhD candidacy) at the end of the second year or at the beginning of the third year. The final requirement is the presentation of a dissertation. Students will be expected to complete the program in three to five years.

A baccalaureate or master’s degree in nursing from a program accredited by NLNAC or CCNE is required for admission to the PhD in nursing program.

For more information about the PhD in nursing program and curriculum details, consult the PhD in nursing program section of the Duke University School of Nursing website and the *PhD in Nursing Program Graduate Student handbook* for 2014-2015. Prospective students may also contact the PhD Program Coordinator Revonda Huppert at (919) 668-4797 or revonda.huppert@duke.edu.

Courses in Nursing (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 philosophy and the history of science and nursing inform discussion about the nature of science and nursing’s past, present and future directions in theory and knowledge development. Students will develop skills in concept and theory analysis related to trajectories of chronic illness and care systems. The student will apply knowledge gained to placing their area of scientific focus into a conceptual framework. Permission of the department required. 3 units.

602. Quantitative Research Designs. This course introduces students to a range of nonexperimental and experimental designs used in health care research. Topics include identifying researchable problems, formulating research questions/aims/hypothesis, conceptual and operational definitions of variables, sampling designs, ethical issues in human subjects research, data collection techniques, and critique of analytical methods. Students will apply knowledge by participating in class discussions, critiquing published research, and exploring possible designs for their research focus. 3 units.

603. The General Linear Models. Focus is on conceptual and methodologic issues involved in the analysis of survey and clinical data using general linear models. Topics include analysis of variance, analysis of covariance, bivariate regression, and multiple regression analyses. Emphasis is on the application of these statistical methods in the design and analysis of nursing and health care research. The student will apply concepts by analyzing archived public domain data using techniques and procedures in SAS. 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 procedures. 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 Methodology. Focus is on theoretical and methodological aspects of interpretive research design. Discusses interpretive 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. Overview of Chronic Illness & Care Systems. This doctoral seminar will provide an overview of science and research on the trajectories of chronic illness and care systems and their intersection. Fall topics will include an overview of the trajectories model, patterns of human responses to chronic illness, approaches to understanding trajectories and development, the care systems and their intersection through which individuals and groups interact to change illness trajectories. Permission of department required. 3 units.

607B. Context of Chronic Illness & Care Systems. This course focuses 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 School 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. Permission of department required. 3 units.

608. Intervention Research Methods in Health Care. Focus is on an in-depth coverage of research designs that address causal relationships as well as critical elements in the design and implementation of intervention studies. Example of topics covered include development of research questions, hypotheses, sampling methods, research designs (quasi-experimental and experimental), reliability and validity (construct, internal and external validity), and intervention fidelity in research around trajectories of chronic illness and care systems. 3 units.

609. Doctoral Seminar in Nursing Science Dissertation. In this doctoral seminar, the student will develop and 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. Permission of department required. 3 units.

611. Introductory Statistics. This course is designed to be an investigation into statistical elements and analyses commonly used in health and behavioral sciences. Focus is on gaining an understanding of statistical elements and tests involved in health science research. Topics will include measures of central tendency and variability, hypothesis testing, descriptive statistics, correlation, t-tests, ANOVA, simple and multiple linear regression, logistic regression, and non-parametric procedures in SAS. A SAS training course is offered as part of the course. The course will examine statistical test assumptions for parametric test involved in nursing research. The student will apply concepts by entering, analyzing, and interpreting data sets using SAS procedures. This course will also provide students with the ability to critically think about research methodology and testing used in nursing research. Fall. 3 units.

612. Quantitative Observational Research Techniques. This course explores quantitative techniques for behavioral observation research. Strategies for developing coding systems, determining reliability and validity, and analyzing data are included. Consent Required. 3 units.

613. Advanced Qualitative Data Analysis for Trajectory Studies. Designed to help student develop skills and understanding relating to the advanced analysis of qualitative data. Course assumes all students will either be in or nearing the analysis stages in their research. Focus on preparation and management of text and media data for analyses; creation and application of various types of coding to data; distinctions in coding data evolving from different qualitative approaches; and analysis of longitudinal qualitative data. 3 units.

614. Mixed Methods Research. Understand the modes of qualitative and quantitative inquiry and the subsequent techniques for collecting, analyzing and interpreting data. Develop necessary skills and knowledge to identify and use different types of research designs and methods. Interpret published empirical studies using mixed methods designs. Produce written work that integrates qualitative and quantitative methods. 3 units.

615. Measurement Theory and Practice. Instrumentation in chronic illness and care system research involves measurement of biological, psychological and/or sociological phenomena. An overview of the theories, principles and techniques that yield reliable and valid measurement of those phenomena. Opportunities will be provided to evaluate the psychometric properties of measures with an emphasis on those designed to measure change over time. Students will have opportunities to evaluate and critique existing measures and/or develop a new measure. Course is designed to aid the student in writing the measurement section of research proposals and reports. 3 units.

698. Doctoral Mentored Teaching Practicum. This practice will focus in 4 areas: Enhance the professional development of PhD students to socialize and prepare them for faculty roles in schools of nursing. Provide a mechanism
for self-evaluation, discussions with mentors about strengths/weaknesses related to teaching and learning in nursing education. Develop and improve teaching skills in preparing for faculty roles. Cultivate relationships between faculty and students who share pedagogical interests. Variable credit.

699. Integrated Research Practicum. Students engage in a research practicum with an experienced researcher. The purpose of the practicum is to develop research skills through participation in the activities of the mentor's program of research. Activities may include grant development, research team meetings, protocol implementation, data analysis and dissemination. Consent required. Instructor: Staff. Variable credit.

Pathology
Professor Pizzo, Chair (301B Davison); Professor Abraham, Director of Graduate Studies (255 Jones); Professors Abraham, Bigner, Chao, Corey, Dewhirst, Dzau, Friedman, Hale, Hoffman, Klintworth, Matchar, Nicchitta, Ortel, Patz, Pizzo, Proia, Sampson, Staats, Sunday, and Zalutsky; Associate Professors Alam, Cunningham, Freedland, Gunn, Haystead, Lin, Marks, Sempowski, Telen, Woods and Yan; Assistant Professors Bachelder, Becher, Datto, Devi, Freedland, He, Krauss, Lawson, Lee, and Levinson

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, infectious diseases and vaccine design, 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 website at pathology.mc.duke.edu.

Courses in Pathology (PATHOL)
725. 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.

750. 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.

785. 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.

786. Translational Aspects of Pathobiology. Translational Research in Pathobiology is an integrated multidisciplinary course designed to provide students with the necessary tools to understand the principle components of the research processes involving patients or materials obtained from a human source. This course reflects the Department of Pathology's unique integration of traditional pathology research with experimental therapeutics in an environment that seeks to bridge the basic sciences and clinical medicine. Instructor: Devi. 3 units.

793. Research Independent Study. Permission of department required. Instructor: Staff. 4 units.

855S. Graduate Seminar in Pathology. Graduate students in the Pathology program present their research in a formal presentation. Instructor: Abraham. 1 unit.

Pharmacology and Cancer Biology
Professor McDonnell, Chair (C238 LSRC); Associate Professor Rathmell, Director of Graduate Studies (C338 LSRC); Professors Abou-Donia, Andrews (pediatrics), Arshavsky (ophthalmology), Blobe (medicine), Casey, Chute (medicine), Counter, Heitman (molecular genetics and microbiology), Kornbluth, Kuhn, Levin (biological psychiatry), Lew, Li (dermatology), MacAlpine, McNamara (neurobiology), Nadler, Newgard, Pendergast, Patz (radiology), Schwartz-Bloom, Slotkin, Sullenger (surgery), Thiele, Wang, Yao.; Associate Professors Chi (molecular genetics and microbiology), Haystead, Hong (chemistry), Kirsch (radiation oncology), Kontos (medicine), Kwatra (anesthesiology), Linardic (pediatrics), Muoio (medicine), Pitt (medicine), Rathmell, Rao (ophthalmology), Spector (medicine),
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 twenty-three primary faculty and twenty-four secondary faculty with primary appointments in departments such as molecular genetics and microbiology, cell biology, cardiology, medicine, and neurobiology. The collaborative and collegial atmosphere between faculty and students provides a wide diversity of research opportunities.

Courses in Pharmacology and Cancer Biology (PHARM)

533. 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 201DL; Mathematics 21 and 122. Instructor: Slotkin and staff. 4 units. C-L: Neuroscience 533

534. 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.

554. 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 201DL, or consent of instructor. Instructor: Abou-Donia and staff. 4 units.

673S. Computer Models and the Treatment of Psychiatric Disorders. 3 units. C-L: see Psychology 673S; also C-L: Computer Science 673S, Information Science and Information Studies 673S

680. Molecular Cardiovascular Biology. 2 units. C-L: Cell Biology 680

693. 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.

694. 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.

730. Stem Cell Course. 3 units. C-L: see Cell Biology 730; also C-L: Molecular Cancer Biology 730

733. Experimental Design and Biostatistics 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, univariate 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 733, Cell and Molecular Biology 733, Biomedical Engineering 733

755. 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 755

760. Cellular Signaling. 3 units. C-L: see Cell Biology 760; also C-L: Biochemistry 760, Molecular Cancer Biology 760
761. Neuropharmacology: From Molecules to Behavior. Seminar-lecture course emphasizing neurotransmitter mechanisms and the mechanisms of action of drugs used to modify nervous system function. Material will be drawn from recent literature. Consent of instructor required. Instructor: Staff. 3 units. C-L: Neurobiology 761

780S. Graduate Student Seminar. A presentation and discussion course in which program faculty and graduate students review recent progress in contemporary areas of Pharmacology and Cancer Biology. Provides an important avenue for evaluation and feedback for graduate student research and communication skills and is required for all students pursuing their Ph.D. degree in Pharmacology and Molecular Cancer Biology. Instructor: Thiele/Wang. 2 units.

793. Research in Pharmacology. Laboratory investigation in various areas of pharmacology. Credit to be arranged. Instructor: Staff. Variable credit. C-L: Molecular Cancer Biology 793

814. Integrated Case Studies in Toxicology. 1 unit. C-L: see Environment 814

815. Focused Topics in Toxicology. 1 unit. C-L: see Environment 815

818. Molecular Mechanisms of Oncogenesis. 2 units. C-L: see Molecular Cancer Biology 818

835. Innovations in Drug Development. Introduction to major issues in developing a drug to treat a disease in an interdisciplinary lecture-based and team-based learning environment. Translation of principles in biomedical sciences, biomedical engineering, and chemistry along with innovative approaches to develop a hypothetical drug for treating a disease of choice. Hypothetical development of model compounds, target analysis, and in vitro and in vivo models to test drug efficacy. Course requires one of the following (or equivalent): Pharm 533, Chem 518, or BME 577 Instructor: Bloom. 1 unit.

847S. Seminar in Toxicology. 1 unit. C-L: Environment 847S

848S. 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 848S

Philosophy

Professor Rosenberg, Chair (201 West Duke); Professor Sreenivasan, Director of Graduate Studies; Professors Adler (law, economics, and public policy), Brandon, Buchanan, Farahany (law, genome sciences & policy), Ferejohn, Flanagan, Gillespie (political science), Grant (political science), Hoover, McShea (biology), Moi (English), Neander, Norman, Purves (neurobiology), Rosenberg, Sinnott-Armstrong, Sreenivasan, and Wong; Visiting Professor van Inwagen; Associate Professor Janiak; Assistant Professor Bernstein, De Brigard and Pavese; Professors Emeriti Golding, and Sanford; Associate Research Professor Hawkins

The Department of Philosophy offers graduate work leading to the MA and PhD degrees.

Seminar discussion complements formal instruction. Students may, after taking a balanced program, specialize in any of the following fields: the history of philosophy (from ancient to twentieth century analytic), epistemology, metaphysics, philosophy of language, philosophy of mind, the philosophical foundations 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 as well as 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 or JD/PhD programs. However, in exceptional cases, the department may admit someone to a master's program even if that person is not concurrently enrolled in another graduate program at Duke. 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 MA. 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 Duke Law School, and JD/PhD students must apply for admission to both the Duke Law School and The Graduate School. Both kinds of students must combine relevant coursework 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 Gopal Sreenivasan, Director of Graduate Studies, Department of Philosophy, Box 90743, 201 West Duke Building, Duke University, Durham, NC 27708-0743; or e-mail him at gopal.sreenivasan@duke.edu. For more information, visit http://philosophy.duke.edu/. To inquire about the JD/MA and JD/PhD programs, applicants should contact the Duke Law School directly, at the following address: Associate Dean of Student Affairs, Duke Law School, Box 90576, Duke University, Durham, NC 27708, or by calling (919) 613-7020.

Courses in Philosophy (PHIL)

502S. Comparative Ethics. Chinese and Western ethics compared, including conceptions of the virtues, the good life, right action, and the person. Instructor permission required. Instructor: Wong. 3 units.

503S. Contemporary Ethical Theories. 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 or Wong. 3 units. C-L: Political Science 582S

506S. 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: Staff. 3 units.

508S. Political Values. Analysis of the systematic justification of political principles and the political values in the administration of law. Instructor: Staff. 3 units.

510S. Adversarial Ethics. Course attempts to identify general principles for designing the rules & regulations for deliberately adversarial institutions (ie; markets, electoral systems/legislatures, criminal law, warfare, sports). Looks at the special virtues of sportsmanship, professionalism, business ethics, etc. people are expected to follow within these hyper-competitive contexts. By examining ways the criteria for being an ethical businessperson, lawyer, soldier, and so on may differ from the criteria for simply being an "ethical person", this course seeks to prepare students for future professional roles in these adversarial domains. No formal pre-requisites. Instructor: Norman. 3 units. C-L: Political Science 585S

511S. Plato. Selected dialogues. Instructor: Ferejohn. 3 units. C-L: Classical Studies 572S

512S. Aristotle. Selected topics. Instructor: Ferejohn. 3 units. C-L: Classical Studies 573S

536S. Hegel's Political Philosophy. 3 units. C-L: see Political Science 676S; also C-L: German 575S

537S. Nietzsche's Political Philosophy. 3 units. C-L: see Political Science 577S; also C-L: German 576S

538S. 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.

539S. Race Theory: Biological Classification and Moral Implications. Topics to include: Biological classification theory and its applications to humans; The fit, or lack thereof, of biological categories and folk classifications of race; The historical/political motivations behind human racial classifications; The role of race in moral interactions; and The role of race in the construction of personal identity. Instructor: Brandon. 3 units. C-L: African and African American Studies 580S

541S. Historical and Philosophical Perspectives on Science. An integrated introduction to the nature of science and scientific change, and its impact on society. Instructor: Janiak or Rosenberg. 3 units. C-L: Literature 521S, Women's Studies 541S, History 577S

551S. 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 or staff. 3 units.
552S. Metaphysics. Selected topics: substance, qualities and universals, identity, space, time, causation, and determinism. Instructor: Bernstein or staff. 3 units.

555S. 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 or Neander. 3 units. C-L: Neuroscience 555S

559. The Biological Basis of Music. 3 units. C-L: see Neurobiology 559; also C-L: Psychology 580

566S. Topics in Early Modern Political Thought from Machiavelli to Mills. 3 units. C-L: see Political Science 579S

570. Body Works: Medicine, Technology, and the Body in Early Twenty-First Century America. 3 units. C-L: see Information Science and Information Studies 670; also C-L: Literature 623

571. Ancient Political Philosophy. 3 units. C-L: see Political Science 575S; also C-L: Classical Studies 571S

573S. Heidegger. 3 units. C-L: see Political Science 581S

590. Special Topics in Philosophy Lecture. Topics vary each semester. Instructor: Staff. 3 units.

590S. Special Fields of Philosophy Seminar (Topics). Instructor: Staff. 3 units.

618S. 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 669S

625S. British Empiricism. A critical study of the writings of Locke, Berkeley, or Hume with special emphasis on problems in the theory of knowledge. Instructor: Janiak. 3 units.

627S. 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: Janiak. 3 units.

628S. Recent and Contemporary Philosophy. A critical study of some contemporary movements, with special emphasis on analytic philosophers. Instructor: Staff. 3 units. C-L: Linguistics 528S

629S. 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, or Rosenberg. 3 units.

631S. Kant’s Critique of Pure Reason. Instructor: Janiak. 3 units.

633S. 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.

634S. 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 organismism, the units of selection, and sociobiology. Consent of instructor required. Instructor: Brandon, Neander, or Rosenberg. 3 units. C-L: Biology 555S

640S. 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 or Neander. 3 units.

650S. Topics in Formal Philosophy. Topics selected from formal logic, philosophy of mathematics, philosophy of logic, or philosophy of language. Instructor: Staff. 3 units.

681S. Wittgensteinian Perspectives on Literary Theory. 3 units. C-L: see Literature 681S; also C-L: English 582S

692S. 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, Sreenivasan, and other faculty from the Trent Center for Bioethics, Humanities, and the History of Medicine. 3 units.
701S. Seminar in Special Fields of Philosophy. Instructor: Staff. 3 units.

702S. ProSeminar in Metaphysics and Epistemology. Close study of texts which drove the development of analytic philosophy & informed current research. Covers texts any analytic philosopher needs to be familiar with. Discussion-based classroom sessions focus on one or two key texts with corresponding reading questions and assigned weekly 2-3 page philosophical essay. Instructor: Einheuser & Janiak. 3 units.

711. 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.

717S. 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.

753S. Principles in Cognitive Neuroscience I. 3 units. C-L: see Psychology 759S; also C-L: Neurobiology 759S

754S. Principles in Cognitive Neuroscience II. 3 units. C-L: see Psychology 760S; also C-L: Neurobiology 760S

785S. Philosophy of Biology. Interdisciplinary discussion group focused on topics in the philosophy of biology. No formal prerequisites, though a background in philosophy or biology is desirable. This course is repeatable over multiple semesters. Instructor: Staff. 0.5 units.

790S. Seminar in Special Fields of Philosophy. Instructor: Staff. 3 units.

795S. Seminar in Teaching Philosophy. Source of pedagogical instruction for graduate students assigned as teaching assistants or course instructors in philosophy courses. Faculty advice about syllabi preparation, discussion of problems that can arise in the college classroom, etc. Course is repeatable across multiple semesters. Instructor: Staff. 0.5 units.

796S. Work in Progress Seminar. For students enrolled in the doctoral program in philosophy. Practice interviews (including filming when possible), mock job talks, etc. Course is repeatable across multiple semesters. Instructor: Staff. 0.5 units.

797S. Dissertation Seminar. Seminar required in the spring semester for grad students going on the job market the following fall. Each student presents material from their dissertation, for discussion with the other graduate students in the seminar and the faculty instructor. Vital part of students preparation for the job market. Note: student must have passed doctoral qualifying examination. Course is repeatable across multiple semesters. Instructor: Staff. 0.5 units.

798S. Philosophical Interlocution. For Philosophy Doctoral Students only: required for all students in residence. Frequently includes meetings with Colloquia speakers to discuss background or related topics. Course is repeatable across multiple semesters. Instructor: Staff. 0.5 units.


950S. Neurophilosophy. Status of such concepts of the 'self,' 'person,' 'free will' in the age of mind science. Conflict between scientific and humanistic images of persons. Varieties of naturalism, neurophilosophy, and neurophenomenology Explanation, prediction, correlations, identities, reduction, levels, laws, functions, and mechanisms in mind science. The logical relations between neurobiology, cognitive, and affective neuroscience, cognitive science, psychology, and social science(s). Instructor: Flanagan. 3 units.

Philosophy 251
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:
  - engages a specific art form in relation to a key philosophical or aesthetic concept;
  - explores the nature of an art form and connects it to key philosophical or aesthetic concepts;
  - examines the connection between philosophy and at least one other art form;
  - focuses on at least one writer/artist and connects them with philosophically informed reflection on the dynamics of form, meaning and/or performance;
  - focuses on at least one key work or number of works, connecting them 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; or
- interdisciplinary experience. Students must take courses in a minimum of three different departments.

For more information, visit [http://www.duke.edu/web/philartslit/](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 coursework 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 the 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 NC State. Students enter the certificate program during their 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; and
- prior enrollment in at least two 100-level courses in biology;

Additional requirements
- two 200-level seminars in philosophy of biology (philosophy department);
- two 200-level courses in evolutionary and/or developmental biology (biology department);
- directed reading class supervised by a faculty member in the center;
• Capstone research paper; and
• regular seminar participation over a two-year period (philosophy of biology).
For more information, visit http://philosophy.duke.edu/graduate/other-degrees-certificates.

Photonics
Professor Wax, Director of Graduate Studies (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 coursework 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 an introductory course in photonics; three courses from the approved course listing; one formal presentation in the Fitzpatrick Institute Seminar Series; attend at least four Fitzpatrick Institute Seminars a year (as documented by the student’s advisor); and if the student is pursuing a PhD, one member of the FIP should be on the PhD dissertation committee. For more information about the program, contact Adam Wax, Box 90281, Duke University Fitzpatrick Center, Durham, NC 27708; (919) 660-5143.

Requirements
• For PhD candidate, one member of the FIP must be on the PhD dissertation committee.
• Certificate accommodates both terminal MS and PhD students who have been admitted to one of the participating departments (biomedical engineering, electrical and computer engineering, computer science, mathematics, chemistry, physics).
• Four photonics courses from the approved course listing, of which one course must be a qualified “Introductory Survey Course” (See the certificate course list at www.fitzpatrick.duke.edu/education/certificate).
• One research presentation for the Fitzpatrick Institute Student Groups. The director of graduate studies will maintain list of approved student seminar series.
• Attend at least four FIP seminars a year.
For more information, visit http://www.fitzpatrick.duke.edu/education/certificate.

Physics
Professor Gao, Chair (137B Physics); Professor Kotwal, Associate Chair for Teaching; Professor Finkelstein, Director of Graduate Studies; Professors Aspinwall, Baranger, Bass, Beratan, Bray, Behringer, Chang, Curtarolo, Edwards, Finkelstein, Gao, Gauthier, Goshaw, Greenside, Howell, Johnson, Katsouleas, Kim, Kotwal, Kruse, Liu, Mueller, Oh, Palmer, Petters, Plesser, Samei, Scholberg, Smith, Socolar, Springer, Warren, Wu, Yang; Associate Professors Chandrasekharan, Driehuys, Dobbins III, Mehen, Teitsworth, C. Walter; Assistant Professors Arce, Barbeau, Buchler, Charbonneau, Lu, Mikkelson; Lecturer Brown; Instructor Roy; Professors Emeriti Evans, Han, Meyer, Roberson, Robinson, Thomas, Tornow, R. Walter, Weller; Adjunct Professors Ciftan, Everitt, Guenther, Lawson, Skatrud, West; Adjunct Associate Professor Ahmed, Daniels, Dutta, Tonchev; Adjunct Assistant Professors Akushievich, Baker

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.
Courses in Physics (PHYSICS)

501. 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 513. Instructor: Staff. 2 units. C-L: Nonlinear and Complex Systems 501

505. 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 464, 465; for graduate students, Physics 764, which may be taken concurrently. Instructor: Arce. 3 units.

509. Quantum Nanophysics. Quantum phenomena in nanostructures, emphasizing interference, dimensionality, and electron interactions. Uses current research topics to introduce fundamental building blocks of the subject, thereby providing in addition a background in solid-state physics. Topics covered may include: graphene, carbon nanotubes, and topological insulators; scanning tunneling microscopy; quantum point contacts and quantum dots; spintronics, single electronics, and molecular electronics; superconducting qubits; giant and colossal magnetoresistance; quantum Hall effect. Emphasis placed on phenomena observed in the last two decades. Prerequisite: Physics 464 or instructor consent. Instructor: Baranger. 3 units.

513. 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 101, Mathematics 216, and Physics 161L, 162L, or equivalent. Instructor: Behringer. 3 units. C-L: Computer Science 524

522. 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 361 and Mathematics 216 or equivalents. Instructor: Chandrasekharan. 3 units.

549. Optics and Photonics Seminar Series. 3 units. C-L: see Electrical and Computer Engineering 549; also C-L: Biomedical Engineering 609

562. Fundamentals of Electromagnetism. Electrostatics, Laplace's equation, multipole expansion, dielectrics, magnetostatics, magnetization, Maxwell equations, gauge transformations, electromagnetic waves, Fresnel equations, and waveguides. Prerequisite: Physics 362 or equivalent and 560. Instructor: Staff. 3 units.

563. Introduction to Statistical Mechanics. Fundamentals of kinetic theory, thermodynamics and statistical mechanics with applications to physics and chemistry. Undergraduate enrollment requires consent of director of undergraduate studies. Prerequisite: Physics 464. Instructor: Staff. 3 units.

566. Computational Physics. Introduction to numerical algorithms and programming methodologies that are useful for studying a broad variety of physics problems via simulation. Applications include projectile motion, oscillatory dynamics, chaos, electric fields, wave propagation, diffusion, phase transitions, and quantum mechanics. Prerequisites: Physics 264L and 363. Experience with a programming language is desirable, but can be acquired while taking the course. Instructor: Bass. 3 units.

590S. Selected Topics in Theoretical Physics. Topics vary as indicated on Physics Department Web site. Consent of Instructor required. Instructor: Staff. 3 units.

603. Representation Theory. 3 units. C-L: see Mathematics 603

607. 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 464, 465, 563. Instructor: Staff. 3 units.
621. **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: Electrical and Computer Engineering 340L or equivalent. Instructor: Adam Wax. 3 units. C-L: Electrical and Computer Engineering 541, Biomedical Engineering 552

622. **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: Staff. 3 units. C-L: Mathematics 527

627. **Quantum Information Science.** 3 units. C-L: see Electrical and Computer Engineering 523


671. **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 465 and 560. Instructor: Staff. 3 units.

715. **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: Physics 464 and Physics 465 or equivalent. Instructor: Springer. 3 units.

719. **Advanced Electrodynamics.** Lienard-Wiechart potentials, scattering theory, radiation theory, MHD and plasmas. Prerequisite: Physics 562. Instructor: Staff. 3 units.

721. **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 561, 562 or equivalents. Instructor: Staff. 3 units.


745. **Accelerator Physics for USPAS.** Introduction to the physics of modern particle accelerators, their design and critical engineering concepts. Topics might include beam dynamics, experimental beam physics, plasma acceleration, the designs of storage ring, cyclotrons, superconducting linacs, induction accelerators, and FELs. May also include critical engineering topics such as vibration control, cryogenics, vacuum systems, and large-scale metrology. 01 Fundamentals of Accelerator Physics .02 Accelerator Physics .03 Experimental Beam Physics .04 Special Topics in Accelerator Physics Lectures by USPAS instructors. Instructor consent required. Instructor: Staff. 3 units.

752S. **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.

760. **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: Mehen. 3 units.
761. Classical Mechanics. Newtonian, Lagrangian, and Hamiltonian methods for classical systems; symmetry and conservation laws; rigid body motion; normal modes; nonlinear oscillations; canonical transformations; Lagrangian and Hamiltonian methods for continuous systems and fields. Instructor: Behringer. 3 units.

762. 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: Teitsworth. 3 units.


764. 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.

765. Graduate Advanced Physics. Dirac equation, canonical field quantization, gauge symmetries, electromagnetic field quantization, identical particles and second quantization, symmetry breaking, gases of interacting bosons and fermions, interaction of quantized radiation field with atoms, Rayleigh scattering, Thomson scattering, nonlinear optical processes, and special topics. Instructor: Chandrasekharan. 3 units.

766S. Physics Research Seminar. Series of weekly presentations on research projects under investigation in the department. Credit/No credit grading only. Instructor: Gao. 1 unit.

771. 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.

772. 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.


804. 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 763 and 816. Instructor: Staff. 3 units.


806. 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.

810. 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 607 or equivalent. Instructor: Staff. 3 units.

813. 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 524 or Physics 513; recommended: Physics 560, 563, or equivalent. Instructor: Staff. 3 units. C-L: Computer Science 724

814. Introduction to Fluid Mechanics. Fundamentals of fluid dynamics. Ideal fluids, viscous fluids, turbulence, boundary layers, heat conduction, relativistic fluids. Prerequisite: Physics 560 and 231. Instructor: Staff. 3 units.

816. Advanced Quantum Mechanics II. Quantum physics of systems of many identical particles, symmetrization, anti-symmetrization, scattering theory, Born approximation, WKB approximation, partial wave expansion, optical theorem, quantization of continuous systems, one-dimensional string, electromagnetic field, spontaneous emission, second quantization. Prerequisite: Physics 715. Instructor: Staff. 3 units.

846. Topics in Theoretical Physics. Topics vary; check Physics Department Web site. Consent of instructor required. Instructor: Staff. 3 units.

861S. 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 719 and 816. Instructor: Staff. 3 units.

995. Graduate Training Internship. Designed to allow graduate student in Physics 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.

Political Science

Professor Knight, Chair; Professor de Marchi, Associate Chair; Associate Professor Beramendi, Director of Graduate Studies; Professors Aldrich, de Marchi, Feaver, Gillespie, Grant, Greco, Hough, Kitschelt, Knight, Lange, McClain, McCubbins, Munger, Niou, Price, Remmer, Rohde, Spragens, Vanberg, Ward, Wibbels; Associate Professors Beardsley, Beramendi, Büthe, Haynie, Hillygus, Leventoglu, Malesky, D. Siegel.; Assistant Professors Balcells, Jardina, Johnston, Kirshner; Research Professors Brennan, Keech; Professors Emeriti Eldridge, Euben, Fish, Hall, Holsti, Horowitz (Law), Johns, Kornberg, McKeen, Paletz, Sokice; Secondary Appointments Professors Hamilton (Public Policy), Jentleson (Public Policy), Krishna (Public Policy), Kuran (Economics), Mayer (Public Policy), Mickiewicz (Public Policy), Roseburg (Philosophy); Associate Professors Hacohen (History), Kelley (Public Policy), and Kelley (Public Policy); Assistant Professors Bermeo (Public Policy), Goss (Public Policy); Johnson (Public Policy), N. Siegel (Law), Adjunct Professors Engstrom, MacKuen, and Stimson; Adjunct Associate Professor Kessler; Associate Professor of the Practice Charney (Public Policy), Maghraoui

The Department of Political Science offers graduate work leading to the MA 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 twelve 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 course credits each, at least half of which must be in political science; (2) two other courses of 3 course credits each or 6 course credits of ungraded research; 3) complete and defend a thesis; a nonthesis option is available. 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 Coursework in the Duke University School of Law

Students at the Duke School of Law earning a MA degree in political science along with the JD degree may take four courses (12 course credits) in political science as part of their required 84 course 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.

Courses in Political Science (POLSCI)

501S. Politics and Media in the United States. 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: Staff. 3 units.

502S. Understanding Ethical Crisis in Organizations. 3 units. C-L: see Study of Ethics 562S; also C-L: Sociology 542S, Public Policy Studies 558S

503S. Crisis, Choice, and Change in Advanced Democratic States. 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.

504S. 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: Staff. 3 units.

505S. Race in Comparative Perspective. 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. C-L: International Comparative Studies 505S

507S. Religion and Comparative Politics. 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: Staff. 3 units.

508S. Public Opinion and 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 or Hillygus. 3 units.

509S. Political Participation: Comparative Perspectives. 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: Staff. 3 units. C-L: International Comparative Studies 511S

510S. Collective Action and Social Movements. 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: Staff. 3 units.

511. Organized Crime in New Democracies. Purpose of course is to explore (i) the conditions under which transitions to democracy in poor and middle-income countries generate waves of organized crime and (ii) the conditions under which criminals embrace insurgent and terrorist actions to control states. Special attention given to the illegal trade of drugs, kidnapping for ransom, extortion, and to the plundering of natural resources. Students will be reading game-theoretic analyses and empirical research based on aggregate data, individual survey data, ethnographies and natural and field experiments. Instructor: Staff. 3 units.

512S. Values and Ideology. Examines the political preferences of the public through in-depth examination of the concepts of "values" and "ideology". Topics include: structure of mass belief systems; core human values and core political values, their nature and origins, and their use in political judgment; nature and meaning of ideological self-identifications; origins of mass ideology in biological and psychological processes; ideology and its dynamics over time at the aggregate level; and relationship of ideology to institutional legitimacy. Instructor: Johnston. 3 units.

515S. Post War Europe, 1945-1968: Politics, Society, and Culture. 3 units. C-L: see History 537S; also C-L: International Comparative Studies 537S

516S. Rule of Law. 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.

517S. Democratic Institutions. 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.

518. The Politics of Health Care. 3 units. C-L: see Public Policy Studies 635

519. The American Party System. 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.

520S. Congressional Policy-Making. Lawmaking and oversight of the executive branch by the U.S. Congress. Committee, party, executive, and interest group roles. Instructor: Rohde. 3 units.

521S. Gender, Identity, and Public Policy. 3 units. C-L: see Public Policy Studies 530S; also C-L: Women's Studies 515S

522S. Comparative Party Politics. 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: Kitschelt. 3 units.

525S. Race and American Politics. A broad overview of the salience of race in the American political fabric and how it structures racial attitudes on a number of political and policy dimensions. Instructor: McClain. 3 units. C-L: African and African American Studies 544S, Public Policy Studies 526S

526S. Markets and Democracy in Latin America. Explores the interaction between markets and democracy in Latin America in relationship to broader theoretical and substantive debates in the field of comparative politics. Addresses competing theoretical perspectives on the interaction between markets and democratic institutions; focuses upon issues of regime change and consolidation with emphasis on the political economy of democratic transi-
tions and institutional change; and examines the politics of market-oriented reform in the new international context of regional development with emphasis on policy formation in Latin America. Instructor: Remmer. 3 units.

527S. Africa in a Global Age. 3 units. C-L: see Cultural Anthropology 561S; also C-L: African and African American Studies 510S, History 561S, International Comparative Studies 510S

543. Counterterrorism Law and Policy. 3 units. C-L: see Public Policy Studies 504

544. 9/11: Causes, Response & Strategy. 3 units. C-L: see Public Policy Studies 561; also C-L: International Comparative Studies 561

545S. International Environmental Regimes. 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: Staff. 3 units. C-L: Public Policy Studies 581S, International Comparative Studies 521S

546S. Assisting Development. 3 units. C-L: see Public Policy Studies 515S; also C-L: International Comparative Studies 514S

547. Politics of United States Foreign Policy. 3 units. C-L: see Public Policy Studies 506; also C-L: International Comparative Studies 506


550S. Predicting Politics: Counter Insurgency, Elections, and Stability. Learn modes of predicting political events and outcomes. Survey of ways that are used to predict US National Presidential and Congressional elections, as well as polls. During election years, will focus on active campaigns. Second half of course devoted to prediction of conflict outbreaks around the world. Students will develop their own data, models, and forecasts for political processes. Pre-requisites: 300 level course in the subfield as well as all general requirements in the major: Political Science 102, 175, and Statistics 101. Instructor: Ward. 3 units.

555S. The Politics of Market Competition in a Global Economy. Course examines history and contemporary political, economic, and legal aspects of antitrust law and its enforcement. Explores evolution of antitrust thought and practice in the United States and Europe over past century, the recent rapid spread of competition laws, as well as domestic and international conflicts and cooperation over competition policy. Students will write original research papers on a related topic of their own choosing. Instructor consent required. Instructor: Buthe. 3 units.

560S. International Relations Theory and Chinese Foreign Policy. 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: Staff. 3 units.

561S. Problems in International Security. 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.

562S. 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: Brands and Feaver. 3 units. C-L: History 567S, Public Policy Studies 501S

563S. Public Opinion and American Foreign Policy. Course will focus on the relationship between American public opinion and U.S. foreign policy. Central areas include: the American public and coherent attitudes about US foreign policy; influence of American leaders and media in the formation of public opinion; how attitudes toward
foreign policy issues influence American elections; and how public opinion influences American foreign policy behavior. Instructor: Staff. 3 units.

573S. Intellectual History and Political Theory. 3 units. C-L: see History 541S

574S. Dissent, Disobedience and Revolution. Examines boundaries of democratic practice - including hate speech, protest, and secession. Key topics in democratic theory will be addressed including scholarly debates over free speech, civil disobedience, and justified revolution. Readings include works by Mill, Locke, Waldron, Buchanan, Cristiano, Elster. Instructor: Kirshner. 3 units.

575S. Ancient Political Philosophy. 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 571S, Philosophy 571

576. Politics and Philosophy of Self and Other. 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 Bakhtin. Instructor: Staff. 3 units.

577S. Nietzsche's Political Philosophy. 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 576S, Philosophy 537S

578S. 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.

579S. Topics in Early Modern Political Thought from Machiavelli to Mills. Topics vary from semester to semester. Topics course. Instructor: Staff. 3 units. C-L: Philosophy 566S

580S. Social Theory and Social Practice. 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 "wertfrei" 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.

581S. Heidegger. 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 573S

582S. Contemporary Ethical Theories. 3 units. C-L: see Philosophy 503S

583S. Thucydides and the Realist Tradition. 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: Staff. 3 units.

584S. Modern Political Theory. 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.

585S. Adversarial Ethics. 3 units. C-L: see Philosophy 510S

586S. Political Thought in the United States. 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.

616S. Persistence and Change in Political Institutions. Persistence and Change in Political Institutions. 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.

617S. The Regulatory Process. 3 units. C-L: see Public Policy Studies 609S

618S. Politics of Institutional Reform. Research seminar focusing on the political economy of institutional change with emphasis on less industrialized and emerging market nations. Open to undergraduates with permission of the instructor. Instructor: Remmer. 3 units.

619. Media and Social Change. 3 units. C-L: see Policy Journalism and Media Studies 676; also C-L: Public Policy Studies 676, Russian 516

630. 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.

631L. 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: Leventoglu or Niou. 3 units.

632. Computational Political Economy. 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: de Marchi. 3 units.

633S. Positive Political Theory. 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 Political Science 352. Instructor: Aldrich or Niou. 3 units.

634. Networks and Interdependence in Political Science. Theory of and empirical support for importance of networks and interdependent behavior in political and social processes. Methodology covered includes tools for empirical analysis of relational data as well as game theoretic and computational/behavioral modeling approaches to analyzing role of network structure. Substantive ties to literatures in political science, economics, and sociology. Instructor: Siegel. 3 units.

642S. Global Inequality Research Seminar. 3 units. C-L: see African and African American Studies 642S; also C-L: Economics 541S, Sociology 642S, Public Policy Studies 645S

644S. The Political Economy of Inequality. Study of the concept and measurement of inequality; evolution of inequality across concepts, space, time (developed and developing world); what explains this evolution; and political consequences of inequality. Instructor: Beramendi. 3 units.

645S. Political Economy of Growth, Stabilization and Distribution. Examines why some nations are rich and others poor; whether financial crises are inevitable; whether economic growth reduces poverty, increases inequality, or both. Addresses extent to which answers to these questions are under human control. Instructor: Keech. 3 units. C-L: Economics 548S, Public Policy Studies 630S

646S. The Politics of European Integration. 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. Instructor: Buthe. 3 units.

647S. International Democratization. 3 units. C-L: see Public Policy Studies 513S
650S. Political Economy of International Relations. Provides an intensive investigation of the major political-economic actors and their interactions in the modern world economy: states, multinational enterprises, and international institutions. Serves as capstone experience for undergraduate students who are pursuing Political Economy or Security, Peace and Conflict as concentrations in political science, or who are pursuing a certificate in Markets and Management. Designed to help graduate students prepare for the qualifying exam in Security, Peace and Conflict and in Political Economy, and to provide them with an opportunity to conduct sustained research in these two fields. Instructor: Grieco. 3 units.

651S. Theories of International Political Economy. Advanced discussion of core issues and the research frontier in IPE (trade, finance, economic development, globalization). Focus on theoretical debates over the source of preferences, the role of power and institutions, conflict and cooperation in the world economy. Open to qualified seniors with consent of the instructor. Instructor: Büthe. 3 units.

658S. Political Economy of Terrorism. Seminar in the formal, quantitative study of subnational terrorism. Addresses historical terror examples, aggregate and individual determinants of terrorism, mobilization and terror networks, methods of terror and counter-terror and their consequences, organization of and competition between terror groups. Focuses on unsolved problems and opportunities for research. Instructor: Siegel. 3 units.

659S. Civil Wars. In-depth examination of internal armed conflict. Exploration of micro and macro level approaches to causes of civil wars; types of civil wars; ethnicity and conflict; warfare; repertoires and dynamics of violence in conflict; armed group organizations and their tactics; relationship between armed groups and the state; duration and termination of internal conflicts; consequences of conflict and processes of transitional justice after conflict termination. Overview of both classical and more recent works on these topics. Instructor: Balcells. 3 units.

660S. Theories of International Conflict. 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: Staff. 3 units.

661S. Courts, Wars, Legacies of Wars. 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 562S

662S. Problems in International Politics. 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.

663S. Energy and U.S. National Security. 3 units. C-L: see Public Policy Studies 583S; also C-L: Environment 583S

664S. Leaders, Nations, and War. 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 160. Instructor: Grieco. 3 units. C-L: International Comparative Studies 664S

665S. Theory and Practice of National Security. 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.
667S. **American Civil-Military Relations.** 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.

668S. **Theory and Practice of International Security.** 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 160 recommended. Instructor: Staff. 3 units.

669S. **Theories of War and Peace in Twentieth Century Europe.** Identify the ways by which history and political science can be used as complementary approaches to the study of the problem of war and peace among nations. Will review major works from the two disciplines that examine the same problem of how to explain the origins of World War I and World War II in Europe. Will also provide students with an opportunity to undertake and present a significant research project that integrates elements of the two disciplines. Instructor: Grieco. 3 units.

670S. **Contemporary United States Foreign Policy.** 3 units. C-L: see Public Policy Studies 502S

675S. **Economy, Society, and Morality in Eighteenth-Century Thought.** Explorations of eighteenth-century topics with a modern counterpart, chiefly (a) self-interest, liberal society, and economic incentive; and (b) the passions, sociality, 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 312. Prerequisites: Economics 205D; and Economics 210D. Instructors: De Marchi and Grant. 3 units. C-L: Economics 547S

676S. **Hegel’s Political Philosophy.** 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 536S, German 575S

677S. **Contemporary Continental Political Thought.** 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.

678S. **Democracy and Constitutionalism.** Study of the essential questions of constitutional democracy and constitutional law: what makes democracy valuable and how constitutions work and are interpreted. Class will provide a strong foundation in both constitutional and political theory. Readings include works by Hamilton, Dahl, Ely, Dworkin, and Ackerman. Instructor: Kirshner. 3 units.

690-1. **Advanced Topics in Political Theory.** Advanced topics in political theory. Instructor: Staff. 3 units.

690-2. **Advanced Topics in Political Institutions.** Advanced topics in political institutions. Instructor: Staff. 3 units.

690-3. **Advanced Topics in Security, Peace and Conflict.** Advanced topics in security, peace and conflict. Instructor: Staff. 3 units.

690-4. **Advanced Topics in Political Behavior and Identities.** Advanced topics in political behavior and identities. Instructor: Staff. 3 units.

690-5. **Advanced Topics in Political Methodology.** Advanced topics in political methodology. Instructor: Staff. 3 units.

690-6. **Advanced Topics in Political Economy.** Advanced topics in political economy. Instructor: Staff. 3 units.

690S-1. **Advanced Topics in Political Theory.** Advanced topics in political theory. Same as Political Science 690-1 except in seminar format. Instructor: Staff. 3 units.

690S-2. **Advanced Topics in Political Institutions.** Advanced topics in political institutions. Same as Political Science 690-2 except in seminar format. Instructor: Staff. 3 units.
690S-3. **Advanced Topics in Security, Peace and Conflict.** Advanced topics in security, peace and conflict. Same as Political Science 690-3 except in seminar format. Instructor: Staff. 3 units.

690S-4. **Advanced Topics in Political Behavior and Identities.** Advanced topics in political behavior and identities. Same as Political Science 690-4 except in seminar format. Instructor: Staff. 3 units.

690S-5. **Advanced Topics in Political Methodology.** Advanced topics in political methodology. Same as Political Science 690-5 except in seminar format. Instructor: Staff. 3 units.

690S-6. **Advanced Topics in Political Economy.** Advanced topics in political economy. Same as Political Science 690-6 except in seminar format. Instructor: Staff. 3 units.

701. **Core in Political Behavior and Identity.** Formation of public opinion in terms of preferences and demands mass publics might direct toward political authorities; the cognitive attribution of causal agency to politicians and collective entities in the political process, as well as the assessment of results of that process; the collectivities that actors identify with as members or the boundaries they draw between their own and other actors' collective memberships/identities, including their affective bases; and the attribution of value and "legitimacy" to political institutions, processes, and entire regimes. Major methods of research to which students are exposed are surveys, experimentation, and qualitative research. Instructor: Staff. 3 units.

702. **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 717

703S. **Racial and Ethnic Minorities in American Politics.** Graduate-level course on politics of the United States' four principal racial minority groups Blacks, Latinos, American Indians, and Asian Americans. Importance of race and ethnicity in American politics is also explored. Instructor: McClain. 3 units. C-L: African and African American Studies 740S, Public Policy Studies 845S

704. **Measuring Public Opinion: Survey Methodology and Design.** 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.

705S. **Political Economy of Macroeconomics.** Study of models of unemployment, inflation, growth, monetary, fiscal, exchange rate, incomes policies and distribution. Also examination of financial crises, political explanations of differences in macro management, financial regulation, and relation to varieties of capitalism. Designed for political science and public policy students without a strong economics background to learn in simple form the "new" macroeconomic models which guide central bank and government policy-making. Instructor: Lange or Soskice. 3 units. C-L: Public Policy Studies 681S

707A. **Marine Policy (A).** 3 units. C-L: see Environment 786A; also C-L: Public Policy Studies 749A

708. **Democracy and the Rule of Law.** Course provides an overview of the normative and positive issues associated with modern democracies and their legal systems. Instructor: Knight and McCubbins. 3 units.

713. **Workshop in Political Behavior and Identities.** Research workshop in political behavior and identities. Instructor: Staff. 1 unit.

714. **Workshop in Political Behavior and Identities II.** Research workshop in political behavior and identities. Students must complete Political Science 769 before taking this course. Instructor: Staff. 1 unit.

715. **Core in Political Institutions.** Studies the formal and informal rules, practices, and regularities at both the domestic and international level that guide and constrain political choices and activities. It is concerned with the emergence, dynamics, and consequences of institutions in both authoritarian and non-authoritarian regimes. Focus includes constitutional design and how the organization of legislatures, parties, judiciaries, markets and other social structures shape relationships between individuals and states, and in turn, the factors shaping the emergence and evolution of those institutions. Instructor: Staff. 3 units.

716. **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.

717S. **Seminar in Political Institutions.** Survey, analysis, and critique of the literature. Instructor: Rohde. 3 units.

719S. 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. 2 units. C-L: Law 717

720S. Capitalism. 3 units. C-L: see Cultural Anthropology 716S; also C-L: Sociology 716S

721. Authoritarian Institutions. Course will survey the exciting new work on the variation, causes, and effects of institutional configurations in authoritarian regimes. Coverage of different regimes types including analysis of particular institutions: party systems and structure; parliaments; elections and electoral systems; local governments and modes of decentralization; and courts and judicial independence. Instructor: Malesky. 3 units.

724. Empirical and Theoretical Approaches to Security, Peace and Conflict. Course provides a survey of the extant, state-of-the-art models in the broad area of Security, Peace and Conflict. Each topic will survey the theoretical and empirical evidence that is marshaled in the literature. Topics include: Strategic Dependencies; Rational Choice; Bargaining: Escalation; Deterrence; Arms Races; Alliances; Mediation; Domestic Politics; Civil Wars; Sanctions; International Institutions; Trade; and other topics. Instructor: Ward and Leventoglu. 3 units.

728. Workshop in Political Institutions I. Research workshop in political institutions. Content of the course continues in Political Science 722. Instructor: Staff. 1 unit.

729. Workshop in Political Institutions II. Research workshop in political institutions. Students must complete Political Science 719 before taking this course. Instructor: Staff. 1 unit.

730. 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.

731. Scope and Methods in Political Science (C-E). Designed to explore philosophical assumptions in political science, theory, and matters of evidence and judgment, the course is meant to be an introduction to variations in research design, empirical methods, and the execution of research. Instructor: Staff. 3 units.

731S. 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.

732. Research Design and Qualitative Methods (M). 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.

733. Maximum Likelihood Methods. 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.

743. Workshop in Political Methodology I. Research workshop in political methodology. Content of the course continues in Political Science 775. Instructor: Staff. 1 unit.

744. Workshop in Political Methodology II. Research workshop in political methodology. Students must complete Political Science 776 before taking this course. Instructor: Staff. 1 unit.

745. Core in Political Economy (PE). Survey of techniques and substantive work in the field. Political economy uses the tools of modern economics and game theory to address questions of fundamental importance at the national
and international level. Analyze the aggregate impact of trade, policies of redistribution, regulations, and assignment of property rights. Study of the "micro," including incentives and individual choice, and the "macro," representing the conflict of social interests and aggregate consequences of individual choices. Instructor: Staff. 3 units.

746S. Seminar on Political Economy: Micro Level. 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.

747S. Seminar in 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.

748. 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.

749S. Advanced Game Theory. Course has two primary aims: 1) better understanding of the technical modeling literature and 2) enhanced ability to write models. Will be exposed to array of different theoretical modeling choices, from signaling and bargaining games to agency problems to behavioral models and computational methods. Instructor: Siegel. 3 units.

750S. Political Economy of Development. Course provides an overview of advanced contemporary research on the political economy of development. Students will work through growth models and attempt to map them onto broader debates in the political economy of development - debates surrounding the impact of institutions, historical legacies, inequality, natural resources, trade, ethnic heterogeneity, foreign aid and the like on prospects for economic development. Extensive use of field and natural-experiments to identify the key instruments of development. Instructor: Wibbels. 3 units.

758. Workshop in Political Economy I. Research workshop in political economy. Content of the workshop continues in Political Science 759. Instructor: Staff. 1 unit.

759. Workshop in Political Economy II. Research workshop in political economy. Students must complete Political Science 784 before taking this course. Instructor: Staff. 1 unit.

760S. Core in Security, Peace and Conflict (SP). Critical survey of theories and research in security and conflict at the international, transnational, and subnational levels. Emphasis will be placed on the interrelation between theory and research. Instructor: Staff. 3 units.

761. Islam and the State: Political Economy of Governance in the Middle East. Introduction to political history of Middle East from the advent of Islam to modern era. Examine institutions responsible for characteristics of political development in the region; consider selected cases relating to mechanisms of political development, including democratization; investigate religion's role in shaping the region's political trajectory; identify social forces, especially economic, driving contemporary rediscovery and reinterpretation of Islam's political organization and requirements, by both Islamists and secular political actors. Instructor: Kuran. 1 unit.

762. The Political Economy of Institutions. 3 units. C-L: see Economics 751


774. Workshop in Security, Peace, and Conflict II. Research workshop in security, peace and conflict. Students must complete Political Science 744 before taking this course. Instructor: Staff. 1 unit.


789. Workshop in Normative Political Theory and Political Philosophy II. Research workshop in normative political theory and political philosophy. Students must complete Political Science 701 before taking this course. Instructor: Staff. 1 unit.
790S. Seminar for Teaching Politics Certificate Program. This course focuses on the problems and special techniques of teaching courses in political science. It meets as a weekly seminar, and brings in faculty from the department to add their perspectives on syllabus design, the large lecture, leading discussions, teaching writing through long papers and short memos, guarding against plagiarism, and other topics. Instructor: Munger. 1 unit.

796S. 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.

797S. 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.

798. 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.

890-5. Political Methodology. Topics on political methodology. Instructor: Staff. 3 units.

890-6. Political Economy. Topics on Political Economy. Instructor: Staff. 3 units.

Psychology and Neuroscience

Professor Cooper, Chair; Professor Bonner, Director of Graduate Studies; Professors Asher, Brannon, Cabeza, Caspi, Cooper Costanzo, Groh, Hariri, Hoyle, Huettel, LaBar, Leary, Meck, Moffitt, Putallaz, Roth, Rubin, Schmajuk, Sikkema, Strauman, Thompson, C. Williams, Whitfield; Associate Professors Bennett, Day, Linnenbrink-Garcia, Marsh, Shah; Assistant Professors Bilbo, Egner, Harris, Mitroff, Richman, Wilbourn, Yin; Research Professor Mazuka, Rabiner, L. Wallach; Assistant Professor the Practice Grimes; Lecturer Batson; Senior Lecturer Fellow Murphy; Medical School Faculty Bonner, Curry, Keefe Robins, Rosenthal, Surwit, R. Williams, Zuker; Professors Emeriti Coie, Eckerman, C. Erickson, R. Erickson, Hall, Kremen, Lockhead, M. Wallach; Faculty with Secondary Appointments: Professors Adcock, Angold, Bettman, Chartrand, J. Compton, J. Costello, DeBellis, Dodge, Edwards, Egger, Fairbanks, Fitzgerald, Fitzsimons, Fitzsimons, Flanagan, Fuemmeler, Gassman-Pines, George, Gibson-Davis, Gold, Goldston, Gustafson, W.C. Hall, Hervey, Holditch-Davis, Kay, R. Keefe, Kollins, Larrick, Levin, Linville, Lisanby, Lubcr, Lynch, Madden, March, Meade, Mauro, Nicolelis, Nowicki, Odgers, Palmer, Payne, Platt, Purves, Reese, Rezvani, Ruse, Schiffman, Serra, Sheppard, Sherwood, Siegler, Smith-Lovin, Spener, Swartzwelder, Vidmar, Weinfurt, Wells, Welsh-Bohmer and Woldorff.

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.

Courses in Psychology (PSY)

510S. Developmental Psychopathology (A, D). Examines emotional and behavioral disorders in childhood and adolescence from a developmental perspective. Issues addressed include biological, cognitive, familial, and social aspects of the disorders and relevant risk and protective factors. Open only to graduate students and advanced undergraduate students. Instructor: Curry. 3 units.

575. Brain and Language (B, C). 3 units. C-L: see Linguistics 510; also C-L: Neuroscience 510

580. The Biological Basis of Music. 3 units. C-L: see Neurobiology 559; also C-L: Philosophy 559

590. 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.

605S. Obesity and Eating Disorders (A,B). A review of obesity and of the major clinical eating disorders (including binge eating disorder, bulimia nervosa and anorexia nervosa) and their pathophysiology, and their treatments. Prerequisite: Introductory Biology. Instructor: Surwit. 3 units.
607S. Personality, Stress, and Disease (A). The role of psychosocial factors in the development and course of physical disease. Both epidemiological and laboratory-based research considered. Become familiar with major behavioral medicine research studies that have made significant contributions to our understanding of the role of psychosocial factors in medical illness and develop skills necessary for critical evaluation of research on psychosocial factors and disease. Appropriate for students with interests in medical careers or in health psychology. Instructor: R. B. Williams. 3 units.

608S. Gender, Pain, and Coping (A). 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.

609S. Psychosocial Determinants of Health (A,S). 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 104 or 105, Research Methods. Open to Juniors, Seniors and Graduate students. Instructor: Richman. 3 units.

610S. The Psychology of Mindfulness Meditation: Theory, Research, and Practice (A). 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: Psychology 102, 105, or 106 desirable. Open to graduate and advanced undergraduate students. Instructor: Robins. 3 units.

611. Global Mental Health. 3 units. C-L: see Global Health 660; also C-L: Cultural Anthropology 611

625S. Motives, Goals, and Social Behavior (S). Covers a variety of topics involving the motivations underlying a variety of social behaviors (such as interpersonal relationships, stereotyping, and achievement) and the social and psychological processes involved when people try to regulate their own motives, thoughts, emotions, and behavior. Reading and discussion of literature on current theory and research on motivation, goal-directed behavior, and self-regulation. Instructor: Shah. 3 units.

627S. Stereotypes and Stigma (S). 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 104. Instructor: Richman. 3 units.

629S. Social Behavior and Personality (A, C,S). 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 include experimental, quasi-experimental, narrative, and observational models. Prerequisites: Psychology 104, Psychology 305, and Statistics 101 or Psychology 201 or other discipline-based statistics course and consent of instructor for undergraduates. Instructor: Hoyle. 3 units.

654S. Psychology of Aging (A,C,D,S). An interdisciplinary approach to the study of aging. Psychological development in middle adulthood and old age as linked to disciplines such as Public Policy, Sociology, Geriatric Medicine & Psychiatry. Age-related changes in well-being, cognition, personality, and social relationships. Real-life issues that will affect most people in the future (e.g., successful retirement, decreasing one's risk of dementia). Open to undergraduate and graduate students. Prerequisites: none. Instructor: Kotter-Gruehn. 3 units.

655S. Children's Peer Relations (D). 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: Asher or Putallaz. 3 units.

658S. Seminar in Emotion (D, S). Theories of emotion, covering biological, developmental, social, ethological, and cultural perspectives. Topics include facial and vocal expression of emotion, individual differences in emotion development, the role of emotion in social relationships, emotion and psychopathology, and emotion and physical health. Prerequisite: Psychology 104 or 114 and consent of instructor. Instructor: Staff. 3 units.

659S. Nonverbal Cognition (B,C,D). 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.

660S. Achievement Motivation. Course provides an in-depth look at the development of achievement motivation in educational settings (primarily elementary through college) from a psychological perspective. Addresses how students' responses to questions such as "Can I do this task?" and "Why do I want to do this task?" shape engagement and learning. Focus will be on how achievement motivation develops and what can be done to promote the development of adaptive forms of motivation. Course readings include an advanced text accompanied by theoretical and empirical journal articles. Instructor consent required. Prerequisites: Junior or Senior status and completion of PSY 103 or 104. Instructor: Staff. 3 units.

665S. 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.

667S. Learning and Cognition in Humans, Animals, and Robots (B,C). Connectionist theories of human and animal learning and cognition applied to robotics. Neural network theories of classical conditioning; concepts of models of the environment, prediction of future events, redundancy reduction, competition for limited capacity short-term memory, mismatch between predicted and observed events, stimulus configuration, inference generation, modulation of attention by novelty, and timing. Neural networks of operant conditioning; concepts of goal-seeking mechanisms, response-selection mechanisms, and cognitive mapping. How neural network models can be used to develop psychological theories, models of the brain, and robots. Instructor: Schmajuk. 3 units. C-L: Neuroscience 667S

668S. 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.

669S. 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 257 or Psychology 275. Instructor: LaBar. 3 units. C-L: Neuroscience 669S

670S. Language, Brain, and Human Behavior. 3 units. C-L: see Linguistics 502S

671S. Nature and Treatment of Eating Disorders Across the Lifespan (A,D). Study of atypical and typical development of conscious somatic sensation, i.e. how individuals sense and understand body signals and how extremes of sensitivity may form part of the core phenomenology of disorders such as anorexia nervosa, pediatric obesity, and autism spectrum disorders. Study of detailed narratives of patients have served as a springboard for novel hypotheses about human function. Readings alternate between primary journal articles to patient memoirs and narratives. Students interview patients struggling with eating disorders, children who binge eat, and children with high functioning autism, among other clinical conditions. Juniors, Seniors and Graduate students. Instructor: Zucker. 3 units.
672S. Cognitive Neuroscience of Memory (B,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 102 or Psychology 106/Neuroscience 101, and consent of instructor. Instructor: Cabeza. 3 units. C-L: Neuroscience 672S

673S. Computer Models and the Treatment of Psychiatric Disorders. Introduce students to the use computational neuroscience modeling for understanding the mechanisms involved in different psychiatric disorders (e.g., anxiety, substance abuse, post-traumatic stress disorder). In the context of computational models, we will then analyze behavioral interventions (e.g., exposure-based therapies) and pharmacological therapies (e.g., administration of haloperidol in the treatment of schizophrenia). Instructor consent required. Instructor: Schmajuk/Rosenthal. 3 units. C-L: Computer Science 673S, Information Science and Information Studies 673S, Pharmacology and Cancer Biology 673S

681S. Genetics and Environment in Abnormal Behavior (A,B,C,D). 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.

684S. 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 584S

685S. Biological Pathways to Psychopathology (A,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. Prerequisite: Psychology 277/Neuroscience 277 or Instructor consent required. Instructor: Hariri. 3 units. C-L: Neuroscience 685S

686S. Principles of Neuroimmunology (B). Bidirectional communication between the brain and immune system, in disease and during normal function/homeostasis. Historical foundations of the field in disorders such as multiple sclerosis and HIV; the anatomy of CNS-immune connections; blood-brain-barrier function and dysfunction; leukocyte trafficking, surveillance, and infiltration of the CNS; cellular players including peripheral vs. CNS-resident immune cells and antigen presentation; neuroinflammation and neurodegenerative disease; recent literature highlighting the critical role of immune molecules in neural development and lifelong plasticity. Instructor consent required for undergraduates. Instructor: Bilbo. 3 units. C-L: Neuroscience 686S

690S. 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.

705. 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.

707. 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.

710. 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.
713S. 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.

715. Seminar in Consumer Behavior. 3 units. C-L: see Business Administration 962

716. Behavioral Decision Theory. 3 units. C-L: see Business Administration 925

717. Political Psychology (A). 3 units. C-L: see Political Science 702

718S. Research Design. Methodology principles of research design in psychology. Experimental, quasi-experimental and correlational research. Permission of instructor required. Instructor: STAFF. 3 units.

720. 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. Consent of instructor required. Instructor: Staff. 3 units.

721. 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: Asher. 3 units.

722. 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.

725. Seminar in Contemporary Psychotherapy. An intensive seminar providing training in a contemporary empirically supported psychotherapy. Includes readings and discussion of the strategies and techniques of the selected treatment modality, examination of the empirical support for the treatment, and where possible, supervised practicum experience providing the treatment to appropriate patient populations. Instructor: Strauman. 3 units.

727S. 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.

729S. Foundations of Cognitive Development. Introduction to main theories and concepts of cognitive development as it is studied from psychological and neuroscience perspectives. Instructors: Brannon. 3 units.

730S. Foundations of Cognitive Psychology. Current concepts and controversies in the way people and other animals perceive, think, and remember. Instructor: Staff. 3 units.

733. 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.

735. 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.
739. **Ethical Issues in Research and Clinical Practice.** Topics including ethical issues in teaching, research, and clinical practice. Instructor: Bonner. 3 units.

743. **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.

744. **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.

745S. **Teaching Practicum.** Experience based on teaching assistantship for fall semester. Instructor: Bonner. 3 units.

746S. **Teaching Practicum.** Experience based on teaching assistantship for spring semester. Instructor: Bonner. 3 units.

748. **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.

749. **Practicum in Psychological Research.** Instructor: Staff. 3 units.

750. **Practicum in Psychological Research.** Instructor: Staff. 3 units.

752. **Child Assessment.** Interview methods; intelligence and achievement testing; personality and developmental batteries; peer, teacher, and parental instruments; and observational techniques. Instructor: Fitzgerald. 3 units.

754S. **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 the 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.

755. **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.

756. **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.

757S. **Cognitive Neuroscience Colloquia.** Graduate students (2nd year and higher) and other research trainees (e.g. postdocs) in cognitive neurosciences 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: Woldroff and staff. 1 unit.

758S. **Cognitive Neuroscience Colloquia.** Graduate students (2nd year and higher) and other research trainees (e.g. postdocs) in cognitive neurosciences 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: Woldroff and staff. 1 unit.

759S. **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 759S, Philosophy 753S

760S. **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 760S, Philosophy 754S

762. Functional Magnetic Resonance Imaging. 3 units. C-L: see Neurobiology 881

763S. Psychology and Neuroscience First Year Seminar I. Introduction to graduate school and academia, talk preparation and practice, grant writing, career paths, ethics. This is a two semester class with 1.5 credits each semester. Instructor: Marsh. 1.5 units.

764S. Psychology and Neuroscience First Year Seminar II. Introduction to graduate school and academia, talk preparation and practice, grant writing, career paths, ethics. This is a two semester class with 1.5 credits each semester. Instructor: Marsh. 1.5 units.

766. 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.

767. 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.

768. 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 reports results of structural equation modeling analyses. Training in the use of relevant software. Mandatory weekly lab sessions. Consent of instructor required. Instructor: Staff. 3 units.

769S. Research Synthesis and Meta-Analysis (G). 3 units. C-L: see Education 794S

770. 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.

771. Social Cognition. 3 units. C-L: see Business Administration 966

772. Automaticity. 3 units. C-L: see Business Administration 965

780S. 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. C-L: Neuroscience 780S

781S. 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.

797. Professional Issues in Clinical Psychology. This course is designed to provide an educational experience that will introduce and enhance the student in the science and profession of clinical psychology. Course topics will address and assure that the student understands critical issues in the professional activities of clinical psychologists, has exposure to a variety of career trajectories, develops appropriate clinical skills in preparation for predoctoral internship training, initiates and is productive in an area of scholarly research, and integrates professional contributions with other important life activities. Instructor: Sikkema. 1 unit.

798. Professional Issues in Clinical Psychology. This course is designed to provide an educational experience that will introduce and enhance the student in the science and profession of clinical psychology. Course topics will address and assure that the student understands critical issues in the professional activities of clinical psychologists, has exposure to a variety of career trajectories, develops appropriate clinical skills in preparation for predoctoral internship. Instructor: Sikkema. 1 unit.

890S. 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.

990. Special Readings in Psychology. Consent of instructor required. Instructor: Staff. 3 units.

Public Policy

Professor Kelly D. Brownell, Dean of the Sanford School of Public Policy; Professor Judith Kelley, Associate Dean for Faculty and Research, Professor Kenneth A. Dodge, Director of Graduate Studies (222 Rubenstein Hall); Professor Mac McCorkle, Associate Professor of Practice & Director of Graduate Studies/MPP Program; Professor Charles Clotfelter, Associate Dean for Academic Programs; Professor Anirudh Krishna, Associate Dean for International Academic Programs; Professors Ananat, Bradley (law), Chafe (history), Clotfelter, Darity, Dodge, Feaver (political science), Fleishman (law), Frankenberg, Hamilton, Jentleson, Korstad, Krishna, Ladd, McClain (political science), Mayer, Merli, Munger (political science), Nechyba (economics), Pizer, Price (political science), Sanders, Schroeder (law), Sloan (economics), Thomas (economics), Vincent (environment), Ubel (business) and Weiner (law) Whetten; Associate Professors Balleisen (history), Bennear (environment), Conrad, Gibson-Davis, Goss, Odgers, Pattanayak, Peck, Pfaff, Profeta, D. Taylor, and Weinthal (environment); Assistant Professors Ananat, Bermeo, Brands, Carnes, Chen (law) Gassman-Pines, Hamoudi, Harding, Jeuland, T. Johnson, Mohanan, Pearson, Rangel, Rose, Sexton. Research Professors Cook-Deegan and Vaupel; Associate Research Professors Lansford and Pickus; Assistant Research Professor Muschkin; Professors of the Practice Bennett, Brown, Frey, Glenday, Harris, Kelly, Pomerantz, Shukla, Skloot, So, Stangl (statistics) and T. Taylor. Associate Professors of the Practice Charney, Fernholz, Krupp, Mirovitskaya, Rogerson and Schanzer; Adjunct Professors Frey, Healy, Nichols, and Yaggy; Lecturers Blount, and Mlyn; Visiting Research Scholars Martin-Staple; Senior Research Scholar Mirovitskaya; Visiting Lecturer Angrist, T. Cook, Elkins, Elson, Emmett, Gergen, Hahn, C. Johnson, Kaufman, D. Hart, Martin-Staple, Moriarty-Lempke, Moses, Prak, Sartor, Webb

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, psychology, 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 defense 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/.
Courses in Public Policy (PUBPOL)

501S. American Grand Strategy. 3 units. C-L: see Political Science 562S; also C-L: History 567S

502S. 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 670S

503S. United States Policy in the Middle East. From World War II to the present with a focus on current policy options. Instructor: Kuniholm. 3 units. C-L: History 509S

504. 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 access to information. Instructor: Schanzer, Silliman. 3 units. C-L: Political Science 543

507S. Intelligence for National Security. Addresses complex US intelligence enterprise that has been established to support our national security priorities. First, students review and discuss current structure of national intelligence apparatus. Case studies are used to evaluate effectiveness and design of intelligence agencies and their accompanying capabilities. Finally, students conduct independent research on select intelligence agencies and organizations. Instructor consent required. Instructor: Nichols. 3 units.

513S. 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 647S

515S. 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 546S, International Comparative Studies 514S

525S. 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.

526S. Race and American Politics. 3 units. C-L: see Political Science 525S; also C-L: African and African American Studies 544S

527S. 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.

528. History of Poverty in the United States. 3 units. C-L: see Study of Ethics 561; also C-L: History 546
529S. Race and Ethnicity. 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: African and African American Studies 551S, International Comparative Studies 529S

530S. 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 521S, Women's Studies 515S

531S. Philanthropy: The Power of Money. Seminar style course designed to deepen understanding of philanthropy and its role in American society. Course will cover Philosophers' history, cultural origins, and influence on social policy. Students will learn how foundations work and issues they face to maintain legitimacy and efficacy. Not an introductory class. Permission required. Some experience in social sector required. Instructor: Staff. 3 units.

532S. Introductory Demographic Measures and Concepts. 3 units. C-L: see Global Health 530S

542S. Schooling 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 549S, Education 542S

544S. 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.

558S. Understanding Ethical Crisis in Organizations. 3 units. C-L: see Study of Ethics 562S; also C-L: Political Science 502S, Sociology 542S

559S. 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.

560S. 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.

561. 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 544, International Comparative Studies 561

562S. Monuments and Memory: Public Policy and Remembrance of Racial Histories. Processes of memorialization of various dimensions of racial pasts, via statuary, 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 541S
563S. 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: Child Policy 634S, Sociology 634S

574. 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 572

575D. Resource and Environmental Economics and Policy. 3 units. C-L: see Environment 520D; also C-L: Economics 530D

575L. Resource and Environmental Economics. 3 units. C-L: see Environment 520L; also C-L: Economics 530L

576. Resource & Environmental Economics I. 1.5 units. C-L: see Energy 520; also C-L: Economics 530

577. Environmental Politics. 3 units. C-L: see Environment 577; also C-L: International Comparative Studies 577

578. Land Use Principles and Policy. 3 units. C-L: see Environment 550

579S. Collective Action, Environment, and 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 579S

580S. Water Cooperation and Conflict. Focuses on potential for transboundary water resources-related conflict and cooperation. Discusses water scarcity concepts, natural resource conflict theory, hydro politics, hydro hegemony, water security, water markets and institutions, game theory, and international water law. Other topics include the economics of water and health. Case studies complement the broader course outlook. Instructor: Jeuland. 3 units. C-L: Global Health 533S, Environment 543S, International Comparative Studies 580S

581S. International Environmental Regimes. 3 units. C-L: see Political Science 545S; also C-L: International Comparative Studies 521S

582. Global Environmental Health: Economics and Policy. 3 units. C-L: see Environment 538; also C-L: Global Health 538

583S. Energy and U.S. National Security. Examines link between reliable, affordable, and sustainable sources of energy and U.S. national security. Includes ethical considerations related to energy resources and wealth distribution, analysis through case study of top foreign oil suppliers to U.S., as well as newer "unconventional" sources of energy such as shale gas and renewables. Extensive use of guest experts from U.S., local and foreign governments as well as industry. Specific skills include thinking like a U.S. diplomat (cross-cultural perspective), writing concise policy memos, and delivering a compelling, succinct oral presentation. Final project will require policy recommendation on an assigned energy security topic. Instructor: Kelly. 3 units. C-L: Political Science 663S, Environment 583S

584. Resource & Environmental Economics II. Variable credit. C-L: see Environment 521; also C-L: Economics 531

585. Climate Change Economics. 3 units. C-L: see Environment 640

590. Advanced Topics in Public Policy. Selected topics. Instructor: Staff. 3 units.

590S. Advanced Topics in Public Policy. Selected topics. Seminar version of Public Policy Studies 590. Instructor: Staff. 3 units.

595S. 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.
596. 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 521, Environment 532

597S. 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 596. Instructor: Conrad. 3 units. C-L: Economics 522S

598. 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, history and institutions in explaining patterns and causes of variations in growth and developmental performance of countries. Effects on growth, development, wellbeing and poverty levels of many current policy issues including HIV/AIDS, financial crises, macro-stability, foreign aid and investment, debt burdens and forgiveness, governance and corruption. Instructor: Fernholz. 3 units. C-L: International Comparative Studies 598

601S. 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.

602S. 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. Instructor consent required. Instructor: Staff. 3 units. C-L: Economics 502S

603S. 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. Public Policy Studies 303D prerequisite or instructor approval. Instructor: Staff. 3 units. C-L: Economics 503S

604. 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 Statistical Science 101 or Public Policy 812 required; further coursework in multiple regression preferred. Consent of instructor required. Instructor: Ananat. 3 units.

605. 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.) Prerequisite: Public Policy Studies 303D or Economics 201D. Instructor: Krupp. 3 units. C-L: Economics 505

606. 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 506

607. Applying Economic Analysis for Environmental and Public Health Project Evaluation. 3 units. C-L: see Global Health 531; also C-L: Environment 563

608S. 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.
609S. The Regulatory Process. 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: Staff. 3 units. C-L: Political Science 617S

610S. Analysis for Strategic Design of Policy and Regulation. Applies tools from welfare economics, information economics, and mechanism design in order to analyze public policy problems in the context of asymmetric information and strategic behavior. Applications include: financial regulation, private and social insurance, corruption and accountability, provision of public goods, and others. Requires previous exposure to intermediate microeconomics (including basic game theory), and reasonable comfort with the mathematics of constrained optimization. Instructor: Hamoudi. 3 units.

630S. Political Economy of Growth, Stabilization and Distribution. 3 units. C-L: see Political Science 645S; also C-L: Economics 548S

633. Topics in 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 534, Global Health 550

634. Ethics and Policy in Genomics. 3 units. C-L: see Genome Sciences and Policy 612; also C-L: Computational Biology and Bioinformatics 612

635. The Politics of Health Care. The history, status, and future of health care policy. Grounded in political theories such as distributive justice, altruism, and contractarianism. Focus on policy formation. Case discussions of American reform controversies in light of international experience. Instructor: Conover. 3 units. C-L: Political Science 518

636. Global Health and Health Systems in Africa. 3 units. C-L: see Global Health 671


638. Global Health Ethics: Interdisciplinary Perspectives. 3 units. C-L: see Global Health 540

639S. 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.

640S. Value for Money in Health Care: Rationing in Theory and Practice. Determining which health interventions and programs are "worth it." Resource allocation and priority setting in practice. Analytical topics of cost benefit and cost effectiveness. Prerequisite: Economics 101 or 201D. Instructor: Staff. 3 units.

641S. Cancer in Our Lives: Film, Narrative, Fiction, History and Politics. Cancer and cancer research viewed through history, narrative, film, fiction. Covers how cancer affects the lives of individuals and families, how cancer research has changed, the politics of cancer research, and the academic-industry-government ecosystem that gives rise to new cancer diagnostics and treatments. Intended for undergrads from humanities, social sciences or sciences and grad or professional students. Heavily discussion-based. Instructor: Cook-Deegan. 3 units. C-L: Genome Sciences and Policy 641S

642S. Designing Innovation for Global Health: From Philanthropy to People. Explores the introduction, adaptation, and globalization across borders of health technologies, with emphasis on resource-limited settings.
Students will critically examine how policy can influence and funding can enable (or not) their innovation and access in low- and middle-income countries. Topics include policies to minimize inequity, systems for sharing and owning knowledge, approaches to innovative financing, and ethical issues. Instructor: So. 3 units.


644S. 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: Staff. 3 units. C-L: African and African American Studies 548S

645S. Global Inequality Research Seminar. 3 units. C-L: see African and African American Studies 642S; also C-L: Economics 541S, Sociology 642S, Political Science 642S

674. 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: Staff. 3 units. C-L: Visual and Media Studies 563

675S. Advanced Magazine Journalism. 3 units. C-L: see Policy Journalism and Media Studies 675S

676. Media and Social Change. 3 units. C-L: see Policy Journalism and Media Studies 676; also C-L: Political Science 619, Russian 516

677S. Federal programs: Using the paper trail to track promises and follow the money. Follows a federal spending or regulatory program from inception through implementation. Research of primary records, including state and local governments, and standard federal sources of primary documents, to compare performance with expectations. GIS and other visualization techniques to analyze program implementation. Website creation to detail program performance. Instructor: Staff. 3 units.

681S. Political Economy of Macroeconomics. 3 units. C-L: see Political Science 705S

700S. 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.

701. 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.

702. Applied Development Economics. This seminar uses macroeconomic and microeconomic principles to analyze developmental challenges. We will use a core textbook to provide an integrated overview of many of the topics covered in the seminar, but the content and structure of the seminar will not follow the textbook and fellows will be required to read more widely and deeply on the topics covered. Many of the topics can be analyzed from both a microeconomis and macroeconomic angle, as well as from an institutional perspective, and the emphasis is on how to use a range of techniques to analyze different problems rather than identifying a problem that lends itself to the application of a particular technique. Instructor: Richard Hemming. 3 units.
703. DCID Summer Academic English Institute. This program is designed to help MIDP international graduate students with their academic studies. This program will develop and strengthen academic English skills and help with acclimation to the US university environment. Please note: this is a non-degree, pre-academic English program. No credits are awarded and it does not count toward any Duke degree. Instructor: Dean Storelli. 0 units.

704. Master's 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: Francis Lethem, Natalia Mirovitskaya, Rosemary Fernholz. 1 unit.

705. Master's Project in International Development Policy. Emphasis on individual projects. Open to MIDP students only. Instructor: Francis Lethem. 2 units.

706. Introduction to Quantitative Analysis. 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 analyses 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: Staff. 1 unit.


721S. 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 inter-agency 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.

723. 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.

724. 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.

725. 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.

726. Innovation and Policy Entrepreneurship. Innovative approaches are increasingly seen as key to solving difficult, complex or new challenges in this century, whether the challenges are local survival in the face of persistent droughts or boosting productivity to meet global competition. It is policy entrepreneurship that is needed to craft the policy innovations or the frameworks that encourage innovation and private sector entrepreneurship. This course will focus on the analytical tools and skills needed by policy makers and analysts to build and sustain an enabling policy environment for innovations and entrepreneurship to occur at global, country and local levels. Instructor: Rosemary Fernholz. 3 units.

727. 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: Joel Rosch. 3 units.

728. 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: Catherine Elkins. 3 units.

729. 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: Vansant. 3 units.

741. Empirical Analysis for Economic Development. The objective of this course is to provide future decision makers with the necessary tools of statistical analysis to enable them to eventually conduct effective empirical analysis of policy issues in economic development. The course focuses on providing tools for using data to gain insight into real development problems for professionals whose primary activity is not advanced data analysis. Instructor: Sandeep Bhattacharya. Variable credit.

749A. Marine Policy (A). 3 units. C-L: see Environment 786A; also C-L: Political Science 707A


751. 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 (2-5 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: Rosemary Fernholz. 1.5 units.

752. 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. We 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: Rosemary Fernholz. 1.5 units.

753. Social Policy in the Context of Development. This course explores the role of social policy as one important approach or channel that policy makers at different levels use to address complex and interrelated issues affecting human wellbeing. It starts with a quick survey of the condition of poverty, high income inequality and structural disadvantage affecting populations across a range of countries in the world, and the achievement of social policies and programs as reflected in human development and Millenium Development Goal indicators. Our main focus in the course, however, is on the national and local levels. Instructor: Fernholz. 3 units.

761. 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: Catherine Admay. 3 units.

762. 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.

770. 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, S. Bhattacharya. 3 units.

771. 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 Public Policy Studies 770, 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: G. Glenday/GP Shukla. 3 units.
772. 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 GP Shukla. 3 units.

773. 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: Richard Hemming. 3 units.

774. 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: Fernando Fernholz. 3 units.

775. 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: Joseph Tham. 3 units.

776. 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: Glenday, Shukla, Kelly. 3 units.

777. Macroeconomic Analysis for the Public Sector. Focuses on how public sector activities and finances affect economic growth and other macroeconomic outcomes. The course develops an accounting and analytic framework that can be used to assess fiscal policy choices, discusses approaches to fiscal targeting, examines tax and expenditure issues from a medium-term perspective, and considers the use of fiscal policy for short-term macroeconomic stabilization. Among the specific topics covered are: debt sustainability, public investment, fiscal responsibility frame-
works, aid and natural resource management, globalization and capital flows, and financial crises. Consent of instructor required. Instructor: Richard Hemming. 3 units.

778. 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. Instructor: Roy Kelly. 3 units.

775. 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.

786. Independent Research Topics in International Development Policy. Selected topics. Consent of instructor required. Instructor: Staff. Variable credit.


790. 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.

792. Special Readings in Public Policy Studies. Instructor: Staff. Variable credit.

803. 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.

804. 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.

807. 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 808, Public Policy Studies 807 or consent of instructor. Instructor: Staff. 3 units.

807D. Master's Project I. Same as PubPol 807 except instruction is provided with a lecture and small discussion meetings each week. Emphasis on individual projects. Preparation of Master's Project. Open to Public Policy students only. A prerequisite for 808 taken in the subsequent semester. 3 units.

808. 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 808, Public Policy Studies 807 or consent of instructor. Instructor: Staff. 3 units.
809. 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.

810. 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 302. Graduate status only. Instructor: Clotfelter or Ladd. 3 units.


812. 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.

812L. Data Analysis for Policy Makers Laboratory. This course teaches students to analyze data using statistical software. Students learn to manipulate a variety of databases, produce analyses and visual displays of quantitative information, interpret results, and write about results. Knowledge of basic statistics, including at least one introductory course, is assumed. 1 unit.

813. 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 604 or equivalent. Instructor: Cook or Gassman-Pines. 3 units.

814. 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.


820. 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.

825. 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.

827S. Environment and Development Economics. 1.5 units. C-L: see Environment 851S

829. Hertie Study Abroad: Special Topics. Graduate-level courses taken at the Hertie School of Governance in Berlin, Germany. 3 units.

830. Special Topics in Leadership and Management. Selected topics. Prerequisite: graduate level. Instructor: Staff. 1.5 units.

845S. Racial and Ethnic Minorities in American Politics. 3 units. C-L: see Political Science 703S; also C-L: African and African American Studies 740S

850. 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.

860. Special Topics in Global Policy and 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.

890. Advanced Special Topics in Public Policy. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. 3 units.

891. Advanced Special Topics in Public Policy. Contents and methods vary with instructors and from semester to semester. Instructor: Staff. Variable credit.

892. 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.

901. 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.

902. 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 student 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.

908S. Dissertation Proposal Seminar I. Required seminar for all 3rd year PhD students in Public Policy preparing to make a dissertation proposal. Instructor: William Darity. 3 units.

909. Dissertation Proposal Seminar II. Required seminar for all 3rd year PhD students in Public Policy preparing to make a dissertation proposal. Prerequisite: Public Policy Studies 908S. Instructor: William Darity. 3 units.

946A. Marine Conservation Summer Institute. 0 units. C-L: see Environment 746A

Religion
Professor David Morgan, Chair (324 Gray); Associate Professor Richard Jaffe, Director of Graduate Studies (115 Gray); Professors Campbell, Chaves, Davis, Fulkerson, Goldman, Goodacre, Griffiths, Huyett, Jones, Kort, Lian, Lischer, Maddox, Marcus, C. Meyers, E. Meyers, Moosa, Morgan, Patton, Peters, Rowe, Surin, Van Rompay; Associate Professors Bretherton, Carter, Chapman, Hall, Jaffe, Jennings, Lieber, Portier-Young, Prasad, Smith, and
The graduate program in religion offers graduate work in numerous programs leading to the MA and PhD degrees. Students may concentrate their studies in one of the following fields of study: Hebrew Bible/Old Testament, New Testament, early Christianity, American religious history, history of Judaism, Islamic studies, Christian theological studies, religion and modernity, and Asian religions.

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 coursework 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 website at http://www.duke.edu/web/gradreligion/ or e-mail, carol.rush@duke.edu.

**Courses in Religion (RELIGION)**

526A. Religion and Civil Society in the Arab World. 3 units. C-L: see Asian & Middle Eastern Studies 526A

550. 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: Staff. 3 units. C-L: Jewish Studies 550

552S. Live Images: Ancient and Medieval Representations of the Divine. 3 units. C-L: see Visual and Media Studies 533S; also C-L: Classical Studies 558S, Medieval and Renaissance Studies 507S

560S. Reading Heidegger. 3 units. C-L: see Asian & Middle Eastern Studies 540S; also C-L: Literature 543S

562S. 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 552S


608. 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 608. Prerequisites: Old Testament 115, 116. Instructor: Chapman, Davis, Peters, or Portier-Young. 3 units. C-L: Jewish Studies 608

609. Rabbinic Hebrew. Interpretive study of late Hebrew, with readings from the Mishnah and Jewish liturgy. Consent of instructor required for undergraduates. Instructor: Staff. 3 units. C-L: Jewish Studies 609


611. 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.
612. Language and Literature of Dead Sea Scrolls. A study in interpretation. Prerequisite: A knowledge of Hebrew. Instructor: Staff. 3 units.

613S. Introduction to Jewish Studies. 3 units. C-L: see Jewish Studies 601S; also C-L: History 601S


630-11. 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.

630-12S. Exegesis of Greek NT II: Hebrews. Consent of instructor required for undergraduates. Instructor: Hays. 3 units.

630-2. Exegesis of the Greek New Testament: Romans. Consent of instructor required. Instructor: Staff. 3 units.


631. 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: Staff. 3 units.

632. Origen. The systematic and apologetic writings of an important Alexandrian thinker and exegete of the third century. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 662


634. Early Christian Asceticism. The development of asceticism and monasticism in the first six centuries of Christianity. Instructor: Staff. 3 units. C-L: Medieval and Renaissance Studies 655

650. Theological Anthropology: Critical Modernists. This seminar will look at theological anthropology in the work of 20th century theologians who develop the tradition of Schleiermacher, a group known as critical revisionists (or revisionist modernists). After recognizing Schleiermacher's contribution, the course will treat theological anthropology in selected contemporary figures such as Paul Tillich, David Tracy, Gordon Kaufman, and Edward Farley. Prerequisite: XTIANTHE 32 or permission of instructor. Instructor: Staff. 3 units.

659. 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.

660. 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: Staff. 3 units. C-L: African and African American Studies 575, Medieval and Renaissance Studies 659

662S. Muslim Networks Across Time and Space. 3 units. C-L: see Asian & Middle Eastern Studies 629S

663. Islam and Modernism. Cultural, religious, and ideological forces that shape Muslim responses to modernism. Instructor: Staff. 3 units.

664. 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.

680S. 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.

690S. Special Topics in Religion. Subject varies from semester to semester. Instructor: Staff. 3 units.
701S. **Elementary Syriac.** Introduction into the language; reading and analysis of simple texts. Instructor: Van Rompay. 3 units.

703S. **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.


705. **Elementary Akkadian.** Study of the elements of Akkadian grammar Reading of neo-Assyrian texts shedding light on the Old Testament. Prerequisite: biblical Hebrew. Instructor: Staff. 3 units.

706. **Elementary Akkadian.** Study of the elements of Akkadian grammar Reading of neo-Assyrian texts shedding light on the Old Testament. Prerequisite: biblical Hebrew. Instructor: Staff. 3 units.

707. **Introductory Sanskrit Language and Literature I.** 3 units. C-L: see SANSKRIT 701

708. **Introductory Sanskrit Language and Literature II.** 3 units. C-L: see SANSKRIT 702

709. **The Septuagint.** A study of the modern critical use of the Greek Old Testament. Prerequisite: knowledge of Greek and Hebrew. Instructor: Peters. 3 units.

710. **Readings in Judaica.** Selected studies in Jewish material culture and problems in Jewish religious and intellectual history. Instructor: E. Meyers and staff. 3 units.

711. **Pharisaic Judaism in the First Century.** An exploration of the principal sources: Josephus, early Rabbinic literature, New Testament. Some consideration of recent secondary literature. Prerequisites: doctoral status or two years of Greek, two years of Hebrew, and some German. Instructor: Staff. 3 units.

712S. **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.

713S. **Greek-Speaking Judaism.** An exploration of selected texts and other evidence from western diaspora, including Joseph and Aseneth, the wisdom of Solomon. parts of Philo, and a few papyri. Secondary literature will include the major studies by E.R. Goodenough and H. A. Wolfson. Instructor: Staff. 3 units.

716S. **The Deuteronomistic History.** Course investigates Martin North's influential characterization of the Former Prophets as literary unity with goal of interpreting Israel's past from Canaan to destruction of Northern and Southern Kingdoms. Evaluates criticisms of North's theory and counter-proposals. At issue is nature of historiography in ancient Israel and its relation to Greek historiography. Consent of instructor required. Instructor: Chapman. 3 units.

717S. **Modern Historical Study of the Prophets.** Within the history of scholarship on biblical prophecy, the late twentieth-century 'turn to the book' entailed the reevaluation of a consensus established one hundred years earlier. By tracing the trajectory of modern critical study of the Bible's prophetic literature, contemporary interpretive debates and theories are contextualized and illuminated. Instructor: Chapman. 3 units.

719S. **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.

720S. **Old Testament Seminar.** Research and discussion on selected problems in the Old Testament and related fields. Fall only. Instructor: Staff. 3 units.

721S. **Old Testament Seminar.** Research and discussion on selected problems in the Old Testament and related fields. Spring only. Instructor: Staff. 3 units.
730S. Seminar in the New Testament. Research and discussion on a selected problem in the biblical field. Fall only. Instructor: Staff. 3 units.

731S. Seminar in the New Testament. Research and discussion on a selected problem in the biblical field. Spring only. Instructor: Staff. 3 units.


735. The Doctrine of the Trinity. Biblical bases, patristic developments, contemporary statements and connections. Instructor: Staff. 3 units.

741. 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.

742. 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 672. Instructor: Staff. 3 units.

743. 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.

744. Pauline Theology. Studies in some aspects of Paulinism in the light of recent scholarship. Instructor: Staff. 3 units.

745. The Theology of Paul: Coherence and Development. "Righteousness by faith" and "being in/dying with Christ" in Paul's letters. Attention paid to internal consistency and chronological shifts. Prerequisites: doctoral status or two years of Greek and good knowledge of German. Instructor: Sanders. 3 units.

746. The Gospel According to Saint Matthew in Recent Research. Instructor: Staff. 3 units.

748S. Theology of St. Thomas Aquinas. Seminar on themes and problems in the thought of Thomas Aquinas. Consent of instructor required. Also taught as Historical Theology 958. Instructor: Staff. 3 units.

749S. Theology of St. Thomas Aquinas. Seminar on themes and problems in the thought of Thomas Aquinas. Consent of instructor required. Also taught as Christian Theology 337. Instructor: Huetter. 3 units.

750S. Seminar in Christian Theology. Research and discussion of a selected problem in the systematic field. Instructor: Staff. 3 units.


752S. Faith and Reason. Variable credit. C-L: see Christian Theology 961

753. Catholic Moral Theology: Its History and Contemporary Issues. The development of Catholic social and moral theory from a historical and analytical perspective. Study of the Catholic social encyclicals as well as the casuistical tradition. Reading of works by Rahner, Haering, Fuchs, Schuller, McCormick, and Curran. Instructor: Staff. 3 units.

754. 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.


757S. Seminar in Theological Ethics. Philosophical paradigms and the nature of the Christian life. Instructor: Staff. 3 units.

758. 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.

760S. Seminar in Contemporary Christian Ethics. Instructor: Staff. 3 units.

765. 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.

770. Islam and Its World. An introduction to the Qur'an, theological doctrines, Islamic law and its interpretations, the Islamic state, the religious "establishment," Sufism, and the sectarian differences between Sunni and Shi'ite Islam as it is practiced in Cairo. Instructor: Staff. 3 units.

775S. Sociology of Religion. 3 units. C-L: see Sociology 775S

799. Special Readings in Religion. Readings vary from semester to semester. Consent of instructor required. Instructor: Staff. 3 units.

803S. Intermediate Syriac. Continuation of reading and analysis of Syriac texts. Instructor: Van Rompay. 3 units.

809. Intermediate Sanskrit. 3 units. C-L: see SANSKRIT 803


812. 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 667. Prerequisite: knowledge of Latin. Instructor: Staff. 3 units.

814. 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.

820. 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: Staff. 3 units.

840. Luther and the Reformation in Germany. The theology of Martin Luther in the context of competing visions of reform. Instructor: Staff. 3 units.

841. The Radical Reformation. Protestant movements of dissent in the sixteenth century. Special attention will be devoted to Müntzer, Carlstadt, Hubmaier, Schwenckfeld, Denck, Marpeck, Socinus, and Menno Simons. Instructor: Staff. 3 units.

842. Calvin and the Reformed Tradition. The theological development of John Calvin. A comprehensive examination of his mature position with constant reference to the theology of other reformers. Instructor: Staff. 3 units.

843. Zwingli and the Origins of Reformed Theology. Instructor: Staff. 3 units.

844. Protestants and Pictures. History of Protestant visual culture from the sixteenth century to the present. Explores images and visual practices that characterize the early formation of European Protestantism, primarily Germany, France, and England, then moves outward to North America and Africa and Asia from the nineteenth century to the present. Special interest in the history of print and mass-produced imagery. Instructor: Morgan. 3 units. C-L: Art History 844

850S. 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.
851. Interpretations of American Religion. An opportunity for advanced students in North American religious studies to deepen their understanding of some of the major questions in the field. Examination of how religious history is actually written—with special attention to the imaginative and moral motivations that enter into that process. Instructor consent required. Instructor: Wacker. 3 units.

852S. Contemporary American Religion. A seminar dealing with trends in American religion in the twentieth century; critical assessment of primary paradigms for interpreting American religious change, and examination of major characteristics and issues facing American religion. Instructor: Wacker. 3 units.


854. 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.

855S. 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.

856. Theology of John Wesley. Critical examination of selected texts of John Wesley with attention to their social and cultural contexts. Instructor: Staff. 3 units.

857. American Religious Biography. Consent of instructor required. Instructor: Staff. 3 units.

858. Catholic Traditions in the United States. Historical exploration of the U.S. Catholic traditions, including Roman Catholicism, independent Catholicism, and other religions' engagements with Catholicism, both friendly and hostile, through primary and secondary texts and other media. Course themes include historiography of American Catholicism, theories of Catholic difference, the new "Catholic Studies," "Catholicizing" the field of U.S. religious history, and professional development. Instructor: Staff. 3 units.

865. Nineteenth-Century European Theology. Protestant theology from Kant to Herrmann. Instructor: Staff. 3 units.

866. Twentieth-Century European Theology. Instructor: Staff. 3 units.

871. Readings in the History of Religion. An examination of the theories, methods, and purposes of the study of non-Western religions within the Western tradition. Instructor: Staff. 3 units.

872. Readings in North American Religious History. Directed research on selected topics in the history of religion in the United States and Canada. Instructor: Wacker. 3 units.

880. Special Problems in Religion and Culture (Topics). Intensive investigation of the relations of religion and modernity, using seminal contemporary texts. Topics announced each semester. Consent of instructor required. Instructor: Staff. 3 units.

882S. Spaces, Bodies, and 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 741S

886. Christian Ethics and Contemporary Culture. A study of the interaction between Christian thought and current social theory. Instructor: Staff. 3 units.

904S. Advanced Syriac. Advanced reading and analysis of Syriac texts. Instructor: Van Rompay. 3 units.

905S. 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.

910S. 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 religious practice from the 16th and 17th century in Europe and Asia, colonial documentation so-called tribal communities, and ethnographic studies of contemporary religious settings ranging from women's storytelling in Himalayan foothills to Cuban Catholicism in United States. Instructor: Prasad. 3 units.


912S. Theorizing Religion. Late nineteenth- and twentieth-century theories, interpretations, and approaches to the study of religion. Instructor: Staff. 3 units.

914. Modernity of Religion. Emergence and form of "religion" in modernity; religions in the context of multiple modernities; exploring both conceptions of "religion" and "modernity" in broadest formulations including particular understandings of culture, power, self and the cosmos; examines cultural grammars, politics, epistemologies, technologies, histories and self-accounts that mark religion-in-modernity drawing on multiple global experiences. Instructor: Prasad. 3 units.

915. Readings in Theology and Language. Sample treatments of religious language in linguistic analysis, hermeneutical theory, literary criticism, liturgical practice, and fundamental theology. Instructor: Staff. 3 units.

916. Topics in the Study of Japanese Religions. An In-depth examination of selected topics in the study of Japanese religions. Advanced Japanese or instructor permission required. Instructor: Jaffe. 3 units.

920. Systematic Theology. Method and structure of systematic theology, the doctrine of God, theological anthropology, and Christology. Instructor: Staff. 3 units.

930S. 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: Staff. 3 units.

940S. Christian Theology/Western Metaphysics. Offers an explanation of the delicate, albeit crucial function of metaphysics in relationship to Christian theology. Also taught as Christian Theology 385. Consent of Instructor required. Instructor: Huetter. 3 units.

941. Philosophical Theology I. Theology, as the knowledge of God, considered in dialogue with selected pagan and Christian philosophers from Plato to Kant. Instructor: Staff. 3 units.

942. Philosophical Theology II. Continuation of Philosophical Theology I. Instructor: Staff. 3 units.

943S. 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: Staff. 3 units.

945. Philosophical Method in Religious Studies. Instructor: Staff. 3 units.

950. 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.

955. Practical Reason and Personal Identity: Explorations in Narrative. This course will deal with questions of the nature of rationality in morality and theology and attend particularly to those suggestions about narrative as the form of such rationality. The readings will involve works by Frei, Ricoeur, Goldberg, MacIntyre, and McClendon, as well as work in literary criticism. Instructor: Staff. 3 units.

960. Moral Theology in the Twentieth Century. Critical and comparative examination of ethical theory as exhibited in the work of selected contemporary theologians. Instructor: Staff. 3 units.

996S. 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 Rosa, Chair, (205 Languages); Professor Gabara, Director of Graduate Studies (205 Languages); Professors Aravamudan, Bell, Dainotto, Dubois, Finucci, Hardt, Jameson, Jenson, Longino, Mignolo, Moi; and Solterer; Associate Professors Eisner, Gabara, Milan, Rodriguez-Garcia, Rosa, Sieburth, and Viego; Assistant Professors Aidoo, Furtado, and Salior; Research Professor Garreta; Professor of the Practice Tufts, Director of the French Language Program; Associate Professor of the Practice Fellin, Director of the Italian Language Program; Associate Professor of the Practice Paredes, Director of the Spanish Language Program

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 other language of study outside the major language is required. (For those following the romance studies track, proficiency in two or more languages is required.)

Course in Creole (CREOLE)

701. Elementary Creole I. Introduction to essential elements of Haitian Creole or Kreyòl language and aspects of Haitian culture. First of two-semester sequence of elementary Haitian Creole or Kreyòl, the course provides practice in understanding, speaking, reading, and writing, culturally contextualized through units on health care, Haitian women's rights issues, and unpaid child servants (restavèk). Students will acquire enough vocabulary and idioms to be able to interact with Haitians. Language instruction will be complemented through additional class meetings with the co-Director of the Haiti Lab and submission of a paper in Creole on aspects of students' Haiti-related research. Taught in Creole. No prerequisite. 3 units.

702. Elementary Creole II. Second semester of elementary Haitian Creole provides essential elements of Creole language and aspects of Haitian culture. Students develop speaking, listening, reading, and writing skills and are exposed to different aspects of Haitian culture through films, storytelling, games, music, and proverbs. Pre-requisite: Creole 701 or a comparable level of previous Creole language experience, such as Duke Engage experience in Haiti or familial background in Creole. Language instruction is complemented through additional class meetings and submission of a paper in Creole on aspects of students' Haiti-related research. Taught in Creole. Instructor: Jenson and staff. 3 units.

Courses in French (FRENCH)

506. 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.

510. Citizen Godard. This course explores the complex interactions of poetics and politics in the films of Jean-Luc Godard, from the French New Wave, through the experimental phase of the Dziga Vertov group, to the recent Histoire(s) du cinéma and Film socialisme. Drawing on a wide range of literary and philosophical texts (Merleau-Ponty, Althusser, Deleuze, Rancière), this seminar situates Godard's work within its intellectual and political contexts, investigating how developments in French culture and thought since 1950 have been reflected in - and sometimes anticipated by - Godard's films. In English with preceptorial available in French. Instructor: Saliot. 3 units. C-L: Arts of the Moving Image 642, Visual and Media Studies 552, Literature 510

510P. Citizen Godard Preceptorial. A preceptorial, in French, requiring recurrent enrollment in French 210. Further information available from instructor. 0 units.

512. 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 512

530. Medieval Fictions. 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 642, Literature 541
531. Imagining Community in Boccaccio and Christine de Pizan. This comparative seminar explores the controversial and complex works of Boccaccio and Christine de Pizan. Boccaccio, illegitimate, impoverished son of a Florentine banker, and Christine de Pizan, an Italian woman isolated at court in Paris during a civil war both use literary form to construct communities--local, linguistic, national, intellectual, gendered, universal. This seminar attempts a different conception of literary community beyond national types and hierarchies offering students opportunities to explore their works and modern critical debates about them. All works available in translation. Readings in original languages and preceptorial meetings for majors and graduate students. Instructor: Eisner or Solterer. 1 unit. C-L: Romance Studies 530, Italian 531

556. 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 587

571. French Symbolism. Poetry and literary theories of Baudelaire, Rimbaud, Mallarmé. Writings of Laforgue, Lautréamont, Huysmans, Louys, and others as they define new aesthetical and ethical values in the framework of the Symbolist and the Decadent intellectual movements. Instructor: Staff. 3 units.

572. 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.

590. Topics in 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 590-1

590S. 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.

690-1. 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.

690-2. 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.

690S-2. Topics in French Literature of the Modern Era. Close study of a particular author, genre, or interpretive category of the 20th century. May include issues such as authorship, translation, reception or critical theory. Instructor: Staff. 3 units.

700S. 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.

701. 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.

702. Medieval Theater 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.

704. 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.

705. 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.
706. Literature of the Eighteenth Century. Problems of literary history, critical reading, and interpretation, focused on varying topics. Instructor: Staff. 3 units.

707. 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.


711. 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.

712. 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.

713. 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, Confiant, Chauvet, Faye, De Certeau, Depestre, Miron. Instructor: Staff. 3 units.

714. 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.

790-1. Topics in Renaissance Prose. Rabelais, Marguerite de Navarre, Montaigne, and others. Instructor: Staff. 3 units.

790-2. Topics in Seventeenth-Century French Literature. Includes genres, authors, movements, and works. Instructor: Longino. 3 units.

790-3. Topics in Modern/Contemporary French Literature. Includes genres, authors, movements, and works. Instructor: Bell or Jameson. 3 units.

890S-1. French Seminar: Special Topics. Topics to be announced. Instructor: Graduate faculty. 3 units.

890S-2. French Seminar. Topics to be announced. Instructor: Graduate faculty. 3 units.

Courses in Italian (ITALIAN)

531. Imagining Community in Boccaccio and Christine de Pizan. This comparative seminar explores the controversial and complex works of Boccaccio and Christine de Pizan. Boccaccio, illegitimate, impoverished son of a Florentine banker, and Christine de Pizan, an Italian woman isolated at court in Paris during a civil war both use literary form to construct communities--local, linguistic, national, intellectual, gendered, universal. This seminar attempts a different conception of literary community beyond national types and hierarchies offering students opportunities to explore their works and modern critical debates about them. All works available in translation. Readings in original languages and preceptorial meetings for majors and graduate students. Instructor: Eisner or Solterer. 1 unit. C-L: Romance Studies 530, French 531

581S. Italian Linguistics. An interdisciplinary study of selected topics, such as history of linguistic theories and language ideologies. Language state formation and citizenship in Italy. Language and power, language and identity. Taught in English. Instructor: Fellin. 3 units.

581SP. Italian Linguistics: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 581S. Further information available from instructor: Instructor: Fellin. 0 units.
583S. Dante Studies. Focus on a particular aspect of Dante's work. Taught in English. Instructor: Eisner. 3 units. C-L: Medieval and Renaissance Studies 615S

583SP. Dante Studies: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 583S. Further information available from instructor. Instructor: Eisner. 0 units.

585S. 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 519S

585SP. Topics in Sexuality and Gender Studies: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 585S. Further information available from instructor. Instructor: Finucci and staff. 0 units.

586S. 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 542S, German 586S, Arts of the Moving Image 640S

586SP. Literary Guide to Italy: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 586S. Further information available from instructor. Instructor: Dainotto. 0 units.

587S. 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.

587SP. Cinema and Literature in Italy: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 587S. Further information available from instructor. Instructor: Dainotto, Finucci, or Hardt. 0 units.

588S. 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 572S

588SP. Antonio Gramsci: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 588S. Further information available from instructor. Instructor: Dainotto, Finucci, or Hardt. 0 units.

590S. Topics in Italian Studies. Specific aspects of Italian history, civilization, culture, and institutions. Topics may vary. Taught in English. Instructor: Dainotto, Eisner, Finucci, Hardt. 3 units.

590S-1. Topics in 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 690S-2, Art History 590S-2

590SP. Topics in Italian Studies -- Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 590S. Further information available from instructor. Instructor: Dainotto, Eisner, Finucci, Hardt. 0 units.

590SP-1. Renaissance Studies: Preceptorial. A preceptorial, in Italian, requiring concurrent enrollment in Italian 584S. Further information available from instructor. Instructor: Finucci. 0 units.

990T. Special Topics Tutorial. Directed reading and research in areas unrepresented by regular course offerings. Instructor: Staff. 3 units.

Courses in Portuguese (PORTUGUE)

512S. 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: 300-level Portuguese course or consent of instructor. Instructors: Furtado, Aidoo, and staff. 3 units.
590. 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. Level of Portuguese required varies with semester topic; students should consult instructor. Instructor: Staff. 3 units.

590S. 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: 300-level Portuguese course or consent of instructor. Instructors: Furtado, Aidoo, and staff. 3 units.

890S. 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 Portuguese 140S and complete a complementary individual research project at the graduate level. Taught in Rio de Janeiro. Instructor: Staff. 3 units.

Courses in Romance Studies (ROMST)

501S. 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 540S

509S. 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.

520S. Translation Studies and Workshop. 3 units. C-L: see Theater Studies 530S; also C-L: Asian & Middle Eastern Studies 502S

521S. Anthropology and History. 3 units. C-L: see Cultural Anthropology 501S; also C-L: History 572S

530. Imagining Community in Boccaccio and Christine de Pizan. This comparative seminar explores the controversial and complex works of Boccaccio and Christine de Pizan. Boccaccio, illegitimate, impoverished son of a Florentine banker, and Christine de Pizan, an Italian woman isolated at court in Paris during a civil war both use literary form to construct communities--local, linguistic, national, intellectual, gendered, universal. This seminar attempts a different conception of literary community beyond national types and hierarchies offering students opportunities to explore their works and modern critical debates about them. All works available in translation. Readings in original languages and preceptorial meetings for majors and graduate students. Instructor: Eisner or Solterer. 1 unit. C-L: French 531, Italian 531

590. Topics in Romance Studies. Topics to be announced. Instructor: Staff. 3 units.

590S. Seminar in Romance Studies. Topics to be announced. Instructor: Staff. 3 units.

690. Topics in Romance Studies. Topics to be announced. Instructor: staff. 3 units.

690S. Seminar in Romance Studies: Special Topics. Topics to be announced. Instructor: Staff. 3 units.

700. 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.

701. Critical Frameworks (Special Topics). 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.

702. Europe in Theory: Culture, Language, Politics. Exploration of the idea of Europe as a political, moral, and cultural identity. Examines the construction of such identity throughout history, ending with today's European Union, at a moment in which integration of "Eastern" countries such as Turkey or Russia remains a hotly debated
issue. Consistent attention devoted to literary, cinematic and artistic works which attempt to imagine a European Culture, as well as the evolution of aesthetics, and literary and art history. Graduate version of ROMST 201. Instructor: Dainotto, staff. 3 units.

790S. 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.

Courses in Spanish (SPANISH)


512S. 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 512S

530. 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.

572. 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.

590S. Seminar in Spanish Literature. Topics to be announced. Instructor: Staff. 3 units.

700S. 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.

701. 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 Poma de Ayala, Alvarado Tezozomoc, Pachacuti Yamki, Alva Ixtlilxochitl. Spanish and Portuguese writers will also be included as well as anonymous texts (for example, Huarocho Manuscripts, Popol Vuh, and Mesoamerican Codices). Instructor: Mignolo. 3 units.

703. Contested Spaces: Writing in Nineteenth-Century Latin America. Questioning teleological constructions of "Literature," "national literature," and the like, this course studies literacy, nonfictional, and pictorial representational practices in nineteenth-century Spanish America and Brazil in their institutional and political setting. Instructor: Mignolo. 3 units.

704. 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.

705. 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 Heliodoran romance. Attention given to such questions as the interaction of literary traditions and social institutions, the philosophical defense of fiction and kinds of censorship, women writers and the representation of women. Instructor: Staff. 3 units.

706. Cervantes. The life and works of Cervantes, with emphasis on the Quijote, the Novelas ejemplares and Persiles y Segismunda. Instructor: Staff. 3 units.
707. 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 comedia; historical and religious drama and protonational self-definition; or performance and the place of the stage as a cultural institution. Instructor: Staff. 3 units.

708. 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: Staff. 3 units.

709. 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.

710. 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.

711. 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.

712S. 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.

713. 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.

714S. 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.

715S. Latin American Vanguards. 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.

716. 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, Marti, Borges, Marsé, Puig, and Martín-Gaite. Instructor: Sieburth. 3 units.

790. Topics in Philosophy, Cultural History, Literature in Latin America. Special topics. Instructor: Mignolo. 3 units.

890-1. Hispanic Seminar: Special Topics. 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.
890-2S. 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 Graduate School, the Nicholas School of the Environment, the Duke Law School, The Fuqua School of Business, or the School of Medicine. 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 a yearly 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**

The Graduate School, The Fuqua School of Business, the School of Medicine, Duke Law School, and Nicholas School of the Environment 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; and
- 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 website at [http://www.duke.edu/web/CSEEES](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; Professors of the Practice Apollonio, Maksimova, McAuliffe; Associate Professor of the PracticeVan Tuyl; Adjunct Professors Newcity and Zitser; Research Scholar Mickiewicz

The Department of Slavic and Eurasian Studies offers graduate work leading to the MA 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 MA degree must be met by completion of coursework and by passing 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 MA program must be completed in four semesters or less.

While the Department of Slavic and Eurasian Studies 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 studies. Admission to the MA program is open.

Further information about the graduate programs, including specific requirements, can be obtained from the director of graduate studies.

Courses in Balto-Finnic (BALTFIN)

701. Elementary Estonian. Introduction to understanding, speaking, reading, and writing Estonian. No preliminary knowledge of Estonian necessary. Instructor: Staff. 3 units.

702. Elementary Estonian. Introduction to understanding, speaking, reading, and writing Estonian. No preliminary knowledge of Estonian necessary. Instructor: Staff. 3 units.

703. Elementary Finnish. Introduction to understanding, speaking, reading, and writing Finnish. No preliminary knowledge of Finnish necessary. Instructor: Staff. 3 units.

704. Elementary Finnish. Introduction to understanding, speaking, reading, and writing Finnish. No preliminary knowledge of Finnish necessary. Instructor: Staff. 3 units.

Courses in Polish (POLISH)

701. Elementary Polish. Introduction to understanding, speaking, reading, and writing in Polish. No preliminary knowledge of Polish necessary. Instructor: Staff. 3 units.

702. Elementary Polish. Introduction to understanding, speaking, reading, and writing in Polish. No preliminary knowledge of Polish necessary. Instructor: Staff. 3 units.

703. Intermediate Polish. Intensive classroom and laboratory practice in spoken and written patterns. Readings in contemporary literature. Prerequisites: Polish 101 and 102, or consent of instructor. Instructor: Staff. 3 units.

704. Intermediate Polish. Intensive classroom and laboratory practice in spoken and written patterns. Readings in contemporary literature. Prerequisites: Polish 101 and 102, or consent of instructor. Instructor: Staff. 3 units.

708S. Fragmented Memories: Polish and Polish Jewish Culture Through Film. Analyzes, compares, and assesses representations of Polish Christians and Polish Jews -- their life experiences, interactions, shared and separate fates -- in documentaries and fiction films made in Poland from the 1930s to the present day. Includes films by Wajda, Polanski, Munk, Kieslowski; also a 2008 documentary about pre-World War II Christian-Jewish relations in Poland by Jolanta Dylewska. All films screened with English subtitles. Instructor: Holmgren. 3 units.

788S. Trauma and Nostalgia: East European Film in the 21st Century. Examines the major thematic focus of East European filmmakers in the 21st century: their efforts to reconstruct and reassess the experience of the Cold War (1945-1989) and the Yugoslav wars (1991-1995). These films from the Czech Republic, Hungary, Poland, Romania, Croatia, and Serbia include ironic/sentimental tales of Cold War childhood, thrillers about sleeping with the enemy
(political informers), and psychological dramas centering on political trauma, resistance, and compromise. All films shown with English subtitles. Instructor: Holmgren. 3 units.

**Courses in Romanian (ROMANIAN)**

703. Intermediate Romanian Language and Culture. Focus on the study of Romanian phonetics, grammar, discourse, textual analysis, and writing. Prerequisite: Romanian 711 or consent of instructor. Instructor: Staff. 3 units.

711. Intensive Romanian Language and Culture. Introduction to Romanian comprehension, speaking, writing, reading, and cultural acquisition. Instructor: Staff. 3 units.

712. Intensive Intermediate Romanian. Intensive study of Romanian at the intermediate level. Equivalent of two semesters. Prerequisite: Romanian 711. Instructor: Staff. 3 units.

**Courses in Russian (RUSSIAN)**


507. 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 204 or consent of instructor. Instructor: Maksimova. 3 units.

508. 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 302S or equivalent. Instructor: Andrews or Maksimova. 3 units.

509. 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.

510. Cognitive and Neurolinguistics. 3 units. C-L: see Linguistics 501; also C-L: Neuroscience 501S

511. The Struggle for Justice and Faith: Russian Literature and Culture, 1855-1900. Considers how Russian writers, artists, and activists addressed 19th-century Russia’s cursed questions of "who is to blame" and "what is to be done": specifically, how to reform an increasingly reactionary autocracy; how to bear witness for an impoverished underclass; what roles women should play in culture and politics; how to resist or improve on a soulless West; how to justify the existence of God in an unjust world. Course texts may include fiction and memoirs by Turgenev, Tolstoy, Dostoevsky, Kovalevskaya, Figner; works of fine art, drama, and opera. Instructor: staff. 3 units.

512. 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.

513. 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.

514. 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.

515S. The Russian Intelligentsia and the Origins of the Revolution. 3 units. C-L: see History 535S

516. Media and Social Change. 3 units. C-L: see Policy Journalism and Media Studies 676; also C-L: Political Science 619, Public Policy Studies 676

517. Russian Poetry. Focus on nineteenth and twentieth centuries, including the Golden Age and the Silver Age. Authors include Pushkin, Lermontov, Bely, Blok, Akhmatova, Tsvetaeva, Mandelshtam, Pasternak, and Mayakovksy. Taught in English or Russian, according to students' Russian language proficiency. Russian texts. Instructor: Van Tuyl. 3 units.

523. Dostoevsky. Introduction to life, works, and criticism. Readings include: Crime and Punishment, The Idiot, and The Brothers Karamazov. Taught in Russian. Instructor: Apollonio or Gheith. 3 units.

525. Tolstoy and the Russian Experience. Historical approach to Tolstoy's depictions of major societal and ethical issues (e.g., war, peace, marriage, death, religion, relationships). Culture of salons, print culture, censorship, and changing political climate. Central questions on the relationship of fiction and history: uses of fiction for understanding history and dangers of such an approach. Readings include selected fiction of Tolstoy, excerpts from journals and letters, and critical and historical accounts of nineteenth-century Russia. Similar to Russian 325 but requires additional assignments. Instructor: Apollonio or Gheith. 3 units.

526. 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.

527S. Chekhov. Drama and prose works. Readings in Russian. Instructor: Apollonio. 3 units.

528S. Bunin: Mystery of the Russian Soul and Metaphysical Memory. Same as Russian 328S, but includes additional assignments. Taught in Russian. Readings in Russian. Intensive critical component. Instructor: Maksimova. 3 units.

529S. 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.


551. Russian Stylistics and Conversation. Refinement of stylistic control and range in spoken and written Russian through intensive textual analysis, including literary (prose and poetry) texts, popular and scholarly journals, and film. Emphasis on fluent discursive skills, as well as development of expository prose style and rhetorical strategies. Taught in Russian. Prerequisite: Russian 401 and 402, or consent of instructor. Instructor: Maksimova. 3 units.

552. Russian Stylistics and Conversation. Continuation of Russian 551. Prerequisite: Russian 401 and 402, or consent of instructor. Instructor: Maksimova. Variable credit.

561S. 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 544S
563. **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: Apollonio. 3 units.

564. **Russian and Slavic Linguistics.** Emphasis on synchronic linguistic theory focusing on East Slavic and Russian, but including diachronic approaches, and West and South Slavic languages. Focus on phonological, morphological, semantic and syntactic structures of Contemporary Standard Russian and modern Slavic languages. Instructor: Andrews. 3 units. C-L: Linguistics 564, Slavic and Eurasian Studies 564

577. **Contemporary Russian Culture: Detective Novels and Film.** Popular novelists and film/television from 1900s-early twenty first century Russia. Theories of genre, anthropological approaches to defining cultural trends, mass cultural phenomena, and impact of globalization. Authors include Marinina, Dashkova, Dontsova, Kunin, Ustinova, and Serova. Readings and films in Russian. Research paper of publishable quality required. Instructor: Andrews. 1 unit.

619S. **The Empire's Western Front: Russian and Polish Cultures.** Exploration through literature and film of the relationship between Russian and Polish cultures in the nineteenth and twentieth centuries when imperial Russia/Soviet Union figured as Poland's problematic "east," and subject state of Poland figured as Russia's problematic "west." Nineteenth century anti-tsarist uprisings, 1920 Soviet-Polish campaign, Poland's postwar sovietization, rise of Solidarity, construction of their respective national identity vis-a-vis another imagined as foe or friend in fiction, drama, film, memoirs. Includes works by Pushkin and Dostoevsky; films by Andrzej Wajda. 3 units.

690S. **Special Topics.** Seminars in advanced topics, designed for seniors and graduate students. Instructor: Staff. 3 units.

701. **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.

701S. **Contemporary Russian Composition and Readings.** Advanced grammar and syntax with intense composition component. Analytical readings in the original. Prerequisite: Russian 703 and 704, or equivalent. Instructor: Staff. 3 units.

702. **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.

703. **Intermediate Russian.** Intensive classroom and laboratory practice in spoken and written patterns. Reading in contemporary literature. Prerequisite: Russian 701, 702 or consent of instructor. Instructor: Staff. 3 units.

704. **Intermediate Russian.** Intensive classroom and laboratory practice in spoken and written patterns. Reading in contemporary literature. Prerequisite: Russian 701, 702 or consent of instructor. Instructor: Staff. 3 units.

705. **Advanced Russian Conversation and Readings.** Nineteenth- and twentieth-century literature in the original. Conducted in Russian. Prerequisite: Russian 703, 704 or consent of instructor. Instructor: Staff. 3 units.

706. **Advanced Russian Conversations and Readings.** Nineteenth- and twentieth-century literature in the original. Conducted in Russian. Prerequisite: Russian 703, 704 or consent of instructor. Instructor: Staff. 3 units.

707. **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 706 or consent of instructor. Instructor: Andrews. 3 units.

708. **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 707 or consent of instructor. Instructor: Andrews. 3 units.

709. **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 707 and 708, or consent of instructor. Instructor: Maksimova. 3 units.

710. **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 707 and 708, or consent of instructor. Instructor: Maksimova. 3 units.
711. The Quest for Identity: Russian Literature and Culture, 1800-1855. Examines how Russian writers and artists distinguished imperial Russia's modern political, social, and cultural identity under "Western eyes." Topics include search for "truly Russian" models, topics, and styles; domestic debate between "Westernizing" and "Slavophile" camps; emergence of women writers; relations between urban and provincial cultures; connections between national identity formation and empire building. Course texts may include fiction, memoirs, and drama by Pushkin, Durova, Gogol, Lermontov, and Pavlova; social commentary by Belinsky and Herzen; works of fine art and folk culture. Instructor: Staff. 3 units.

711AS. 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 706 or equivalent. Instructor: Staff. 3 units.

712AS. 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 706 or equivalent. Instructor: Staff. 3 units.

713. 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 204 or equivalent. Instructor: Andrews. 3 units.


717. Russian Art and Politics: 1800-Present. Historical and contemporary engagement of visual culture-painting, sculpture, architecture, graphic arts, film, photography-with the political sphere in Russia from the early nineteenth century to the present. Interactions between artists, art critics, censors, government authorities, and the public indicating how visual culture both responded to demands from the political sphere and shaped the political discourse of the day. Instructor: Kachurin. 3 units.

720S. End of Life in Russia & U.S. Brief history of hospice movement in US and Russia. Examine key moments in end of life issues in each country; focus on social attitudes to death and dying and their effects on end of life care. Sources include memoirs, fiction, theoretical works, and policy documents. Service learning course; includes work at sites such as the Unicorn Bereavement Center, a skilled nursing facility, or the state's attorney's office. Instructor: Gheith. 3 units.

721. The New Russia: Reflections of Post-Soviet Reality in Literature and Film. Examination of fiction and film in the post-Soviet period. Topics include: crime and social breakdown in the 1990s and 2000s; transformations of classic character types (anti-hero, virgin-whore, swindler-rogue); religious and ethical quests; taboo-breaking themes. Works by authors Sorokin, Grishkovets, Pelevin, Petrushhevskaya, Sadur, Shishkin, Minaev, Tolstaya, Akunin, Ulitskaya and filmmakers Bodrov, Rogozhkin, Bekmambetov, Khlebnikov/Popogrebsky, Balabanov, and Sokurov. Readings and class discussions in English. Instructor: Apollonio. 3 units.

730. Beat Generation/Russian New Wave: Cultural Dissent in the Cold War. Exploration of identity formation and cultural dissent in the US and Soviet Union during the Cold War through the lens of Beat Generation and New Wave literature and film; explores cultural dissent in relation to both a given culture context but also considers how such dissent is read and appropriated in comparative contexts; introduces students to key figures/features of the respective movements, placing these in historical context; figures include: Kerouac, Burroughs, Ginsberg, Snyder, R. Frank, Aksyonov, Bitov, Akhmadulina, Voznesensky, Visotsky, Tarkovsky and Yevtushenko. Instructor: Need/Gheith. 3 units.

733S. Soviet Life through the Camera's Lense. An in-depth look at images and representations of Soviet life through Soviet and Russian film. Film texts include films shown in theatres, television films and forbidden films/films with a very limited distribution. Emphasis on the period from the mid-1970s through 1991. Course taught in Russian. Instructor: Maksimova. 3 units.

753. Law, Culture, and the Russian Legal Tradition. The development of the Russian legal tradition, with particular emphasis on the historical, ethical and cultural factors that have contributed to its emergence, comparing the Russian tradition with the Western legal tradition. How law, lawyers, and legal institutions have been portrayed
and perceived in Russian popular culture, especially Russian literature, including the relationship between secular legal institutions and the Russian Orthodox Church. Taught in English. Instructor: Newcity. 3 units.

773S. Russian Language and Culture through Film. Study of Russian cultural paradigms and constructs of self and other as demonstrated in Russia and Soviet films, primarily from 1960s to the present. Special attention to the analysis of linguistic constructs and their cultural semantic content as well as comparative analyses of Soviet and Russian culture and Russian and European/American culture. Film and computer technology, as well as access to these technologies and their implementation, are a central part of the cultural context. Includes oral and written presentations and analysis which require the usage of additional film text and secondary critical literature. Prerequisite: Russian 301S or equivalent or consent of instructor. Instructor: Maksimova. 3 units. C-L: Visual and Media Studies 773S

774S. Russian Language and Culture through Film II. 3 units. C-L: see Visual and Media Studies 719S

782. Art and Dissidence: Films of Tarkovsky, Kubrick, Kurosawa, and Lynch. Post-World War II Soviet and United States identity and culture explored through the lens of dissident film art; the use of inter-textuality and contrasting media to critique culture; film and visual art studied in relation to other modern, post-modern, positivist modes of expressing and constructing knowledge. Graduate section will have additional separate meetings, readings, film viewings, and writing assignments. Instructor: Gheith. 3 units. C-L: Art History 782

783. The Actress: Celebrity and the Woman. Explores through fiction, film, autobiographies, and biographies the significance and influence of the actress (on stage and screen) from eighteenth century to present day. Highlighted topics: actress's self-image and perception of her art; relationship between her public profession and private life; how she reflects/sets contemporary standards for beauty and lifestyle; how she provokes public debate over women's "appropriate" sexual, familial, professional, and public roles; her function as symbol/role model for her gender, race, nation. Includes Sarah Bernhardt's memoirs, Chekhov's The Seagull, Susan Sontag's In America, films All About Eve and Mommie Dearest. Taught in English. Instructor: Holmgren. 3 units.

790. Teaching Methodology. Application of linguistic principles in the classroom. No prior knowledge of linguistics required. Instructor: Staff. 2 units.

990. Directed Readings. Advanced readings in nineteenth- and twentieth-century Russian literature in the original. Instructor: Staff. 3 units.

Courses in Serbian and Croatian (SERBCRO)

701. 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.

702. 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.

Courses in Eurasian Studies (SES)

564. Russian and Slavic Linguistics. Emphasis on synchronic linguistic theory focusing on East Slavic and Russian, but including diachronic approaches, and West and South Slavic languages. Focus on phonological, morphological, semantic and syntactic structures of Contemporary Standard Russian and modern Slavic languages. Instructor: Andrews. 3 units. C-L: Russian 564, Linguistics 564

712. Accelerated Uzbek Language and Culture I. Accelerated study of contemporary Uzbek language and culture. Intended for students with no previous knowledge of Uzbek: speaking, reading, writing, grammar and listening comprehension and appropriate use of cultural constructs. Instructor: Staff. 3 units.

713. Accelerated Uzbek Language and Culture II. Continuation of Uzbek 10. Intermediate level of proficiency in five areas: grammar, speaking, listening comprehension, reading and writing. Language taught embedded in cultural constructs. Prerequisite: Uzbek 10 or equivalent. Instructor: Staff. 3 units.

723S. City Stops Between Europe and Asia: From Prague to Kabul. Explores the multi-layered histories and identities of cities positioned on imperial routes extending from Europe's eastern borders into Central Asia--Prague, Warsaw, Kazan, Istanbul, Bukhara/Tashkent, Kabul. Examines how these urban spaces bear the political, religious, cultural, and linguistic imprints of overlapping empires--Mongol, Ottoman, Hapsburg, Russian, and Soviet. No prerequisites. All readings in English translation and films screened with English subtitles. Instructor: Tuna. 3 units.
740S. Around the Bloc: Cold War Culture in the USSR and Eastern Europe. Drawing on oral and written history, memoirs, film, fiction, and essays in anthropology and sociology, we'll resist the black/white readings imposed by the Iron Curtain and explore the dreams, fears, ethical concerns, cultural trends, and lifestyles of Cold War baby boomers in the USSR, Poland, Czechoslovakia, and Romania. Highlighted topics include: the privileges and discontent of postwar youth, the atomic age and its mutations, adventures in socialist consumer culture, gender politics and real life, making art about the socialist state of the absurd. All texts in English translation, films screened with English subtitles. Instructor: Holmgren. 3 units.

756. Imperial Russia 1700-1917. Russian imperial history from Peter the Great to Bolshevik Revolution: 1700-1917. Focus on formation and governance of multiethnic and multiconfessional Russian empire. Traces expansion of land-locked city state (Muscovy) into world power ruling from Eastern Europe to Alaska. Questions implications of Russia's world-power status. Examines institutions of governance that created this empire and held its various ethnic, religious and ideological groups together for centuries. Readings of English translations of works of Russian literature and historiographic analyses aimed at developing a sound grounding in Russian imperial history and culture. Instructor: Tuna. 3 units.

772S. The Frontiers and Minorities of the Tsarist and Soviet Empires. Introduces multiconfessional, multilingual, multicultural composition of Russian & Soviet empires with questions concerning minorities in an imperial context. Learn about construction, interaction, and manipulation of cultures and identities. Balance Tsarist & Soviet efforts to modernize and Russify minorities, such as Ashkenazi Jews, Poles, & Turkic Muslims, against negotiated transformation and cultural resilience of minorities. Recognizes cultural diversity in an imperial setting and provides better appreciation of Russian and Eurasian realities and other multicultural contexts such as America. No Russian required. Instructor: Tuna. 3 units.

773S. Between Moscow, Beijing and Delhi: Narratives of Europe and Asia. Exercise in reconstructing Eurasian history from the 13th century Mongol invasions to post-Soviet era through critical reading of eyewitness accounts--travel notes and memoirs. Reflects on political, religious, and cultural evolution, expansion, and rivalry as well as cross-cultural and trans-regional exchange. Instructor: Tuna. 3 units.

786S. Borderland and Battleground: A journey Through Twentieth-Century Eastern Europe. Explores through history, film, fiction, and memoirs the "extreme" political experience, hybrid ethnic identities, and stunning art and testimony of twentieth-century Central and Eastern European cultures, including Poland, Czechoslovakia, Hungary, Romania, and Yugoslavia. Traces the emergence of new nation states in the region at the end of World War I, the rise of Nazism and Stalinism, the devastating experience of World War II, and the absurdist mix of politics and daily life in Eastern Europe from 1945 until the fall of the Berlin Wall. Instructor: Holmgren. 3 units.

990. Directed Readings. Advanced Readings in Turkish Language and Culture. Instructor: Staff. 3 units.

Courses in Turkish (TURKISH)

607S. 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: Gökñar. 3 units.

608. 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: Goknar. 3 units.

645S. 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: Gökñar. 3 units.
690S. Special Topics. Seminars in advanced topics, designed for seniors and graduate students. Instructor: Staff. 3 units.

701. Elementary Turkish. Introduction to understanding, speaking, reading, and writing Turkish. Instructor: Staff. 3 units.

702. Elementary Turkish. Introduction to understanding, speaking, reading, and writing Turkish. Second half of Turkish 701, 702. Prerequisite: Turkish 701. Instructor: Staff. 3 units.

703. Intermediate Turkish. Classroom and laboratory practice in spoken and written patterns. Readings in contemporary literature. Prerequisites: Turkish 701 and 702, 14, or consent of instructor. 3 units.

707. Contemporary Turkish Composition and Readings. Advanced grammar and syntax with intense composition component. Analytical readings in the original. Prerequisite: Turkish 703 or equivalent. Instructor: Staff. 3 units.

708. Contemporary Turkish Composition and Readings. Continuation of Turkish 707. Prerequisite: Turkish 707. Instructor: Staff. 3 units.

712. Accelerated Turkish Language and Culture I. Accelerated study of contemporary Turkish language and culture. Intended for students with no previous knowledge of Turkish: speaking, reading, writing, grammar and listening comprehension, and appropriate use of cultural constructs. Instructor: Goknar. 3 units.

713. Accelerated Turkish Language and Culture II. Continuation of Turkish 712. Intermediate level of proficiency in five areas, grammar, speaking, listening comprehension, reading and writing. Language taught embedded in cultural constructs. Prerequisite: Turkish 712 or equivalent. Instructor: Goknar. 3 units.

718. The Turks: From Ottoman Empire to European Union. Readings in cultural history and literature to examine transformations in Turkish identity from the Ottoman era to EU accession. Discussion of the "gazi thesis", the "sultanate of women", religious tolerance (millet), conversion, modernity and nationalism. Secondary topics include Sufism, Islam, gender, and historiography. Interdisciplinary focus. Taught in English. Instructor: Goknar. 3 units.

Courses in Ukrainian (UKRAIN)

701. Elementary Ukrainian. Introduction to understanding, speaking, reading, and writing Ukrainian. No preliminary knowledge of Ukrainian necessary. Instructor: Staff. 3 units.

702. Elementary Ukrainian. Introduction to understanding, speaking, reading, and writing Ukrainian. No preliminary knowledge of Ukrainian necessary. Instructor: Staff. 3 units.

Sociology

Professor Bonilla-Silva, Chair (268 Sociology-Psychology); Professor Vaisey, Director of Graduate Studies (327 Sociology-Psychology); Professors Bonilla-Silva, Burton, Chaves, Gao, George, Gereffi, Harris, James (public policy), Keister, Land, Moody, O'Rand, Ruef, Smith-Lovin, Spennner, and Yi (Center for Study of Aging and Human Development and Geriatric Division, Department of Medicine, Medical School); Associate Professors Baker (cultural anthropology), Crichlow (African and African American studies), Gibson-Davis, Gold (psychiatry), Frankenberg (public policy), Healy, Merli (public policy), Read, and Vaisey; (public policy); Assistant Professor Streib; Professors Emeriti Lin, Maddox, McPherson, Simpson, Smith, Tiryakian, and Wilson

The department offers graduate work leading to the MA and PhD degrees in sociology.

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 eight core courses. In addition, the student is to take three professionalization seminars (Sociology 702, 703, 901) for the exposure of frontier research issues and professional activities in sociology. The core courses include Sociology 710 (Classical Sociological Theory), Sociology 711 (Contemporary Approaches to Sociological Explanation), Sociology 722 (Social Statistics I) and Sociology 723 (Social Statistics II), Sociology 720S (Logic of Inquiry) or equivalent, Sociology 721S (Research Design Practicum), and two additional advanced methods courses (to be determined by the student with approval of the DGS). Preliminary exam topics are developed with your advisor, but typically include population studies, comparative and historical sociology, cultural sociology, economic sociology, medical sociology, stratification, social psychology, networks,
religion, and race. A student entering with only an undergraduate degree would need to take seventeen courses to satisfy degree requirements.

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.

Courses in Sociology (SOCIOL)

534. Topics in Population, Health, and Policy. 3 units. C-L: see Public Policy Studies 633; also C-L: Global Health 550

541. The United States and the Asian Pacific Region. Asian Pacific region is major engine of economic growth in the 21st century likely causing major shift of power and wealth in the world. Study relationships between US and various Asian Pacific nations from the end of World War II to present. Focus on impact of wars, technological development and economic development. Examine differences in various issues such as trade, human rights, environment, territory disputes between US and a variety of Asian Pacific nations. Same as Sociology 341, with additional work required. Instructor: Gao. Variable credit.

542S. Understanding Ethical Crisis in Organizations. 3 units. C-L: see Study of Ethics 562S; also C-L: Political Science 502S, Public Policy Studies 558S

556S. Poverty and the Visual. 3 units. C-L: see Visual and Media Studies 570S

590. Special Topics in Sociology. Substantive, theoretical, or methodological topics vary by semester. Instructor: Staff. 3 units.

594S. Cultural (Con)Fusions of Asians and Africans. 3 units. C-L: see African and African American Studies 594S; also C-L: Cultural Anthropology 594S, Latin American Studies 594S

634S. Making Social Policy. 3 units. C-L: see Public Policy Studies 563S; also C-L: Child Policy 634S

636S. Experimental Communities. 3 units. C-L: see Visual Arts 554S

641S. Proseminar in Medical Sociology (Special Topics). 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, or Moody. 3 units.

642S. Global Inequality Research Seminar. 3 units. C-L: see African and African American Studies 642S; also C-L: Economics 541S, Political Science 642S, Public Policy Studies 645S

645S. Citizen and Subject in a Neoliberal Age. 3 units. C-L: see African and African American Studies 641S; also C-L: Cultural Anthropology 641S

650S. 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 550S

651S. 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 542S


690. Special Topics in Sociology. Substantive, theoretical, or methodological topics vary by semester. Instructor: Staff. 3 units.

690S. Seminar in Selected Topics. Substantive, theoretical, or methodological topics. Instructor: Staff. 3 units.

701. 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.

702. Second-Year Paper Workshop. 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. 1.5 units.

703. Developing a Dissertation Proposal. A two-semester workshop in which students develop their dissertation proposals. Instructor: Staff. 3 units.


711. Contemporary Approaches to Sociological Explanation. Second theory course for first-year sociology graduate students. Explanatory sociological theory from the mid-20th century to the present. Prerequisites: Sociology 710 or equivalent. Instructor: Staff. 3 units.

716S. Capitalism. 3 units. C-L: see Cultural Anthropology 716S; also C-L: Political Science 720S

720. 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: Staff. 3 units.

720S. Logic of Inquiry. 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: Chaves, Moody, Vaisey. 3 units.

721S. Research Practicum. Explores sociological research methods. Focuses on basic elements shared by all sociological research: research questions, research design, measurement, sampling, and data collection. Will sharpen students' research skills, help them distinguish good from poor matches between research questions and research methods, and equip them to design and execute high quality sociological research. Instructor: Chaves or Keister. 3 units.

722. Social Statistics I: Linear Models. Introduction to regression modeling for first-year sociology graduate students; multiple regression in matrix form; least squares and maximum likelihood; generalized linear models; regression diagnostics; model selection. Prerequisites: department statistics "boot camp" or equivalent. Instructor: Harris, Moody, or Vaisey. 3 units.

723. Social Statistics II: Advanced Techniques. Advanced methods for first-year sociology graduate students; content varies but may include: logit, probit, and other generalized linear models; propensity score and other forms of matching; instrumental variables; panel and multilevel data; simulations. Prerequisites: Sociology 722 or equivalent. Instructor: Moody or Vaisey. 3 units.


726S. 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.

728S. Advanced Methods: Introduction to Social Networks. Introduction to social network analysis (SNA). History of SNA; social-theoretical foundations of modern network analysis; data collection; data management; analysis and visualization tools. Survey of current applications of SNA within the social sciences. Satisfies Sociology PhD program advanced methods requirement. Instructor: Moody. 3 units.

730S. Proseminar: Topics in Comparative and Historical Sociology. Selected topics in the differentiation and transformation of societies: theories of social change; globalization and comparative development; societal transfor-
mations and social institutions; culture, values, and ideas; social movements and political sociology; comparative social policies; comparative and historical sociology. Instructor: Gereffi or staff. 3 units.

745S. Proseminar in Crime, Law, and Deviance (Special Topics). 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.

750S. Proseminar in Population Studies (Special Topics). Selected topics: population dynamics; mortality, morbidity, and epidemiology; urbanization and migration; demography of the labor force; demography of aging; population studies. Instructor: Burton, Land, Moody, or O'Rand. 3 units.

755S. Proseminar in Economic Sociology (Special Topics). Selected topics: basic concepts, theories, and methods; organizations and institutions; social networks and social capital; globalization and markets; occupations and work. Instructor: Gao, Gereffi, Keister, Merkx, or Spenner. 3 units.

760S. Proseminars in Social Institutions and Processes (Special Topics). 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.

765S. Proseminar: Topics in 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: Keister, Spenner, or O'Rand. 3 units.

770S. Proseminar in Social Psychology (Special Topics). 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, Smith-Lovin, or Spenner. 3 units.

775S. 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 775S

776. The Social Organization of American Religion. 1 unit. C-L: American Christianity 807

790. Selected Topics. Lecture version of Sociology 690S. 3 units.

790S. Seminar in Selected Topics. Substantive, theoretical, or methodological topics. Restricted to Sociology graduate program majors only. Instructor: Staff. 3 units.

791. 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 721S or consent of instructor. Instructor: Staff. 3 units.

901. Advanced Writing Workshop. Research writing workshop required for sociology graduate students. Prerequisite: Sociology 703. Instructor: Staff. 1.5 units.

Statistical and Economic Modeling
Assistant Professor Surya Tokdar, MS Director in Statistical Science (219A Old Chemistry); Professor Kent Kimbrough, Director of MA Studies and Professor of Economics (227 Social Sciences).

The masters program in statistical and economic modeling is a joint program between the departments of statistical science and economics. Students preparing to enter this program will find an undergraduate background in mathematics, engineering, computer science, statistics, or economics to be helpful. It is designed to train and develop statistical skills linked to economics, finance, policy, and related areas to prepare graduates for PhD studies or related professions. Students complete coursework in both statistics and economics. Graduates will be awarded an MS in statistical and economic modeling as their degree.

Students must complete a minimum of 30 course credits: 12 course credits in select statistical science courses (Statistical Science 521, 523, 531, 532, 601, 621, 663, 841, 942, 944 or substitutes approved by the statistical science MS Director), 12 course credits in select economics courses (Economics 601, 602, 605, 606, 608D, 612, 613, 552, 690, 701, 702, 703, 705, 706, 707, 713 or approved substitutes, with no more than six course credits from any one of the subfields of microeconomics, macroeconomics, and econometrics), and six course credits for the independent research paper guided by three faculty members from both departments. Additional statistical science courses particularly relevant for the joint program include Statistical Science 622, 623, 863, 942, 944. Remedial or preparatory courses may also be required, including EIS courses as mandated, Mathematics 216 (Linear Algebra/Differential Equations), Mathematics 431 (Advanced Calculus), Statistical Science 230 (Probability), Statistical Science 250 (Statistics), Statistical Science 611 (Probability and Statistics), and Economics/Computer Science 690 (Numerical Methods).

Each student has a completion meeting with his/her committee, involving a presentation and discussion of either a portfolio of completed work from course projects and papers, and/or a summary of applied work from an internship, and/or an independent study project mentored by faculty member(s) from the two departments. The completion exercise is reviewed and approved for master's credit by the faculty advisor(s) in consultation with the program directors.

**Economics Courses (ECON)**
552. Economic Growth. 3 units.
601. Microeconomics. 3 units.
605. Advanced Microeconomic Analysis. 3 units.
602. Macroeconomic Theory. 3 units.
606. Advanced Macroeconomics II. 3 units.
608D. Introduction to Econometrics. 3 units.
612. Time Series Econometrics. 3 units.
613. Applied Econometrics in Microeconomics. 3 units.
701. Microeconomic Analysis I. 3 units.
705. Microeconomic Analysis II. 3 units.
702. Macroeconomic Analysis I. 3 units.
706. Macroeconomic Analysis II. 3 units.
703. Econometrics I. 3 units.
707. Econometrics II. 3 units.

**Statistical Science Courses (STA)**
521. Modern Regression and Predictive Modeling. 3 units.
523. Programming for Statistical Science. 3 units.
531. Advanced Bayesian Inference and Stochastic Modeling. 3 units.
532. Theory of Statistical Inference. 3 units.
601. Modern Statistical Data Analysis. 3 units.
621. Applied Stochastic Processes. 3 units.
622. Statistical Data Mining. 3 units.
Statistical Decision Theory. 3 units.
663. Statistical Computing and Computation. 3 units.
841. Generalized Linear Models. 3 units.
942. Time Series and Forecasting. 3 units.
944. Spatial Statistics. 3 units.

Statistical Science

Professor Clyde, Chair (214 Old Chemistry); Professor West, Director of Graduate Studies; Professors Berger, Clark, Dunson, Gelfand, Hauser, Mattingly, Reiter, Winkler and Wolpert; Associate Professors Chan, Mukherjee and Schmidler; Assistant Professors Engelhardt, Heller, Li, Ma, Reeves, Tokdar; Professor Emeriti Burdick and Sacks; Professors of the Practice Banks and Stangl; Assistant Professors of the Practice Çetinkaya-Rundel and Lock-Morgan; Associate Research Professor Iversen; Adjunct Professor Bayarri; Adjunct Associate Professor Lucas.

The Department of Statistical Science at Duke University offers graduate study leading to the PhD degree in statistical science, the MS degree in statistical science, and the MS degree in statistical and economic modeling.

The PhD in statistical science offers thorough preparation in the theory and methods of statistics, with major emphases on modern, model-based statistical science, Bayesian and classical approaches to inference, computational statistics, and machine learning. 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 areas (biomedical sciences, economic and policy sciences, environmental sciences, engineering, information sciences and machine learning, physical sciences, and others). The rich opportunities for students in interdisciplinary statistical research at Duke are complemented by departmental interconnections at the National Institute of Statistical Science (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.

The master's in statistical science emphasizes core expertise in predictive modeling, Bayesian methods, machine learning, computational science and modern analytics linked to interdisciplinary applications. In addition to defining a premier graduate educational program at MS level, the MSS couples into the research leadership of Duke statistical science faculty. For some MSS students, the program defines a professional launch-pad for careers in modern statistical science and related areas. For others, it is a bridge to future PhD studies.

The master's in statistical and economic modeling integrates the leading educational opportunities of Duke statistical science at the master's level with those of the Duke economics department. MSEM emphasizes educational opportunities and studies geared towards professional careers in statistics and economics, as well as an entree path to potential future PhD studies. This unique program is jointly administered by the departments of statistical science and economics.

For an up-to-date faculty list and description of the graduate programs in statistical science, visit the website at http://www.stat.duke.edu.

Courses in Statistical Science (STA)

501S. Teaching Advanced Placement Statistics. Designed for students in MAT (Masters in Education Program) who want to go on to teach statistics in high schools. Content covers advanced placement curriculum as well as discussion on the pedagogy of teaching statistical science in high schools. Typically offered only in the summer, occasionally during the academic year. Instructor consent required. Instructor: Stangl. 3 units.

502. Bayesian Inference and Decision. 3 units. C-L: see Business Administration 910

503. Choice Theory. 3 units. C-L: see Business Administration 913

504. Statistical Genetics. 3 units. C-L: see Computational Biology and Bioinformatics 541

521L. Modern Regression and Predictive Modeling. Exploratory data analysis techniques and visualization of data with interactive graphics. Multiple linear regression and model building, predictive distributions, penalized and Bayesian estimation, model selection and model uncertainty including variable transformations, variable selection,
and Bayesian model averaging, diagnostics and model checking, robust estimation, hierarchical models. Instructor consent required. Prerequisites: Statistics 210, 230 and 250, or equivalents; Statistics 601 (or co-registration). Instructor: Clyde, Dunson and/or Gelfand. 3 units.

523L. Programming for Statistical Science. Statistical programming, computation using selected languages and environments (Python, R, Matlab, and/or C/C++) and their interfaces with custom code development for central statistical models. Best practices and software development for reproducible results, selecting topics from: use of markup languages, understanding data structures, design of graphics, object oriented programming, vectorized code, scoping, documenting code, profiling and debugging, building modular code, and version control-all in contexts of specific applied statistical analyses. Designed to complement STA 601. Instructor consent required. Prereqs: STA 210, 230 and 250, or equivalents; STA 601 (or co-registration). Instructor: Chan, Clyde, Iversen. 3 units.

531. Advanced Bayesian Inference and Stochastic Modeling. Art and science of building graphical models and stochastic simulation methods for inference and prediction. Mixture models, networks, and other latent variable probability models, i.e. hidden Markov models. Review of discrete and continuous multivariate distributions used in building graphical models, tools of linear algebra and probability calculus. Aspects of Monte Carlo methodology and related dynamical modeling theory. Statistical computing using Matlab or R. Instructor consent required. Prerequisites: Statistics 521L, 523L, 601. Instructor: Schmidler or West. 3 units.

532. Theory of Statistical Inference. Core mathematical foundations of classical and Bayesian statistical inference. Theory of point and interval estimation and testing based on efficiency, consistency, sufficiency and robustness. Maximum likelihood, moments and non-parametric methods based on exact or large sample distribution theory; associated EM, asymptotic normality and bootstrap computational techniques. Theoretical aspects of objective Bayesian inference, prediction, and testing. Selected additional topics drawn from, for example, multiparameter testing, contingency tables, multiplicity studies. Instructor consent required. Prerequisites: Statistics 521L, 523L, 601. Instructor: Berger, Gelfand, Li, Tokdar. 3 units.

561D. Probabilistic Machine Learning. Introduction to concepts in probabilistic machine learning with a focus on discriminative and hierarchical generative models. Topics include directed and undirected graphical models, kernel methods, exact and approximate parameter estimation methods, and structure learning. Prerequisites: Linear algebra, Statistical Science 250 or Statistical Science 611. Instructor: Schmidler or West. 3 units.

563. Information Theory. 3 units. C-L: see Electrical and Computer Engineering 587

581. ProSeminar: Becoming a Statistical Scientist. Statistical paradigms and current directions, communication of statistical ideas and arguments, statistical ethics, overview of study designs, building a statistical network, professional societies, developing a web/social media presence, career paths. Instructor consent required. Prerequisites: Statistics 531, 532, 523L (or co-registration). Instructor consent required. Instructor: Staff. 1 unit.

582L. DataFest. Students work in teams to solve this year’s big data challenge on campus. Engages students with the data analysis process from the definition of research/analysis questions, to in-depth exploratory analysis, to formal modeling and computational developments, to drawing conclusions based on their findings. Students interact with multiple faculty and expert advisors, and develop and present their findings to a panel of professors and professionals. Prerequisites: Statistics 531, 532, 523L (or co-registration). Instructor: Çetinkaya-Rundel. 1 unit.

601. Bayesian and Modern Statistical Data Analysis. Principles of data analysis and modern statistical modeling. Exploratory data analysis. Introduction to Bayesian inference, prior and posterior distributions, predictive distributions, hierarchical models, model checking and selection, missing data, introduction to stochastic simulation by Markov Chain Monte Carlo using a higher level statistical language such as R or Matlab. Applications drawn from various disciplines. Not open to students with credit for Statistical Science 360. Prerequisite: Statistical Science 210, 230 and 250, or close equivalents. Instructor: Clyde, Dunson, or Reiter. 3 units.


612. Numerical Analysis. 3 units. C-L: see Computer Science 520; also C-L: Mathematics 565
613. Statistical Methods for Computational Biology. 3 units. C-L: see Computational Biology and Bioinformatics 540

614. Computational Structural Biology. 3 units. C-L: see Computer Science 664; also C-L: Computational Biology and Bioinformatics 550

621. Applied Stochastic Processes. 3 units. C-L: see Mathematics 541

622. 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: Statistical Science 250. Instructor: Banks or Ma. 3 units. C-L: Computer Science 579


640. Causal Inference. Statistical issues in causality and methods for estimating causal effects. Randomized designs and alternative designs and methods for when randomization is infeasible: matching methods, propensity scores, longitudinal treatments, regression discontinuity, instrumental variables, and principal stratification. Methods are motivated by examples from social sciences, policy and health sciences. Prerequisites: Statistics 531, 532, 523L. Instructor: Li. 3 units.

641. Statistical Learning and Bayesian Nonparametrics. Nonparametric Bayesian models and methods for complex data analyses with non-linearity adjustment, flexible borrowing of information, local uncertainty quantification and interaction discovery. Focuses on computationally and theoretically efficient nonparametric regression techniques based on advanced Gaussian process models, with motivating applications in causal inference and big data genomics. Includes several illustrative examples with R codes. Basic coverage of asymptotic theory and MCMC and greedy algorithms. Prerequisites: Statistics 531, 532, 523L. Instructor: Tokdar or Dunson. 3 units.

642. Time Series and Dynamic Models. Statistical models for modeling, monitoring, assessing and forecasting time series. Univariate and multivariate dynamic models; state space modeling approaches; Bayesian inference and prediction; computational methods for fast data analysis, learning and prediction; time series decomposition; dynamic model and time series structure assessment. Routine use of statistical software for time series applications. Applied studies motivated by problems and time series data from a range of applied fields including economics, finance, neuroscience, climatology, social networks, and others. Instructor consent required. Prerequisites: Statistics 531, 532, 523L. Instructor: West. 3 units.

643. Modern Design of Experiments. Classical and Bayesian design notions and techniques-- experimental units, randomization, treatments, blocking and restrictions to randomization, and utility of designs. Optimal sample size determination for estimation and testing. Factorial and fractional factorial designs, response surface methods, conjoint designs, sequential designs and bandit problems used in on-line advertising. Design and modeling of complex computer experiments. Designs for multiple objectives. Computational algorithms for finding optimal designs. Prerequisites: Statistics 531, 532, 523L. Instructors: Berger, Banks, Clyde, or Gelfand. 3 units.

663L. Statistical Computing and Computation. Statistical modeling and machine learning involving large data sets and challenging computation. Data pipelines and data bases, big data tools, sequential algorithms and subsampling methods for massive data sets, efficient programming for multi-core and cluster machines, including topics drawn from GPU programming, cloud computing, Map/Reduce and general tools of distributed computing environments. Intense use of statistical and data manipulation software will be required. Data from areas such as astronomy, genomics, finance, social media, networks, neuroscience. Instructor consent required. Prerequisites: Statistics 521L, 523L; Statistics 531, 532 (or co-registration). Instructor: Chan. 3 units.
690. Special Topics in Statistics. Prerequisite: Statistical Science 611 or consent of instructor. Pass/Fail grading only. Instructor: Staff. 3 units.

690-40. Topics in Probability Theory. 3 units. C-L: see Mathematics 690-40

701S. Readings in Statistical Science. Advanced seminar on topics at research frontiers in statistical sciences. Consent of instructor required. Instructor: Staff. 1 unit.

711. 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: Mukherjee or Wolpert. 3 units.

721. 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: Statistical Science 611 and 601 or equivalent. Instructor: Clyde. 3 units. C-L: Mathematics 743

723. Case Studies in Bayesian Statistics. Advanced Bayesian statistical modelling from an applied perspective; problems and data from a range of application areas; focus on statistical thought and practice with in-depth examination of applications; statistical topics drawn from multilevel modelling, randomization and experimental design, causal inference, meta analysis, item response models, models for categorical data, time series, model assessment and criticism, scientific communication. Instructor consent. Instructor: Clyde. 3 units.

732. 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 predictive perspective. Applications include estimation and testing in normal models; model choice and criticism. Prerequisite: Statistical Science 611 and 831 or consent of instructor. Instructor: Li, Tokdar, or Wolpert. 3 units.

790. Special Topics in Statistics. Prerequisite: Statistical Science 611 or consent of instructor. Pass/Fail grading only. Instructor: Staff. 3 units.


832. Multivariate Statistical Analysis. Review of matrix algebra, transformations, and Jacobians. The multivariate normal, Wishart, multivariate t, and related distributions are given special emphasis. Topics such as principal components, factor analysis, discrimination and classification, and clustering treated both from classical and Bayesian viewpoints. Additional topics depending on instructor and background of students. Prerequisite: Statistical Science 732 and 841. Instructor: Schmidler or West. 3 units.

841. Models and Methods for Categorical Data. This course covers statistical methods for analyzing categorical data. Model and theory includes: generalized linear models, including models for binary data, polytomous data (ordered and unordered), counts, contingency tables, matrix and graphical data. Classical and Bayesian inference in these models involves: latent variable representations, conditional likelihood, profile likelihood, and iterative algorithms. More advanced methods include: analysis of repeated measurements, data with cluster structure, nonparametric analysis, adaptive testing in contingency tables, multiple testing and data analysis in high-dimensions. Prerequisites: STA 721 and 732, or consent of instructor. Instructor: Ma. 3 units.

851. 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: Cetinkaya-Rundel or Lucas. 1 unit.
863. **Advanced Statistical Computing.** Advanced numerical methods and algorithms for statistical computing, emphasizing techniques relevant to modern Bayesian statistical research. Topics drawn from: numerical linear algebra, optimization, advanced Monte Carlo simulation and integration, approximate Bayesian computation, variational methods, belief propagation, distributed computing, and other areas of current research. Prerequisite: STA 831, 832. Instructor: Dunson, Mukherjee, or Schmidler. 3 units.

941. **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 or Ma. 3 units.


944. **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.


993. **Independent Study.** Directed reading and research. Consent of instructor and director of graduate studies required. Instructor: Staff. Variable credit.

994. **Independent Study.** Directed reading and research. Consent of instructor and director of graduate studies required. Instructor: Staff. Variable credit.

**Structural Biology and Biophysics**

Professor Terrence Oas, *Director* (biochemistry); Professor Harold Erickson, *Director of Graduate Studies* (cell biology); twenty-nine participating faculty members in seven departments

This is an admitting program.

A certificate is also available in this program.

The Structural Biology and Biophysics Program brings together an interdisciplinary group of chemists, biochemists, physicists, computational biologists, cell biologists, biomaterials scientists and biomedical engineers to interact and discuss problems of common interest. These include physical and computational studies of 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, 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:
  - Structural Biochemistry
  - Structural Biology and Biophysics 681 (Physical Biochemistry)
  - Biochemistry 695 (Structural Methods)
  - Structural Biology and Biophysics 622 (Structure of Biological Macromolecules)
  - Structural Biology and Biophysics 546S (Structural Biology & 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 Structural Biology and Biophysics Program, visit [http://sbb.duke.edu/](http://sbb.duke.edu/).

**Courses in Structural Biology and Biophysics (SBB)**

**546S. Structural Biology and 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.

**622. Structure of Biological Macromolecules.** 3 units. C-L: see Biochemistry 622; also C-L: Computational Biology and Bioinformatics 622

**658. Structural Biochemistry I.** 2 units. C-L: see Biochemistry 658; also C-L: Cell and Molecular Biology 658, Cell Biology 658, University Program in Genetics 658, Immunology 658, Computational Biology and Bioinformatics 658

**659. Structural Biochemistry II.** 2 units. C-L: see Biochemistry 659; also C-L: Cell Biology 659, Immunology 659, Computational Biology and Bioinformatics 659, University Program in Genetics 659

**681. Physical Biochemistry.** 3 units. C-L: see Biochemistry 681

**682T. 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.

**Women's Studies**

Professor Khanna, **Director** (210 East Duke Building); Associate Professor Wilson, **Director of Graduate Studies** (210B East Duke). Professors Grosz, Khanna (english and literature), Rudy; Associate Professors Hasso (international comparative studies, and sociology), Weeks, Wilson (cultural anthropology); Assistant Professor of the Practice Rosenberg; **Associate Faculty:** Professors Fullerson (divinity), Holloway (English), Nelson (cultural anthropology), Piot (cultural anthropology and African and African American studies), Silverblatt (cultural anthropology), Wald (English), Wiegman (literature); Associate Professors Lubiano (African and African American studies), Mottahedeh (literature), Rojas (Asian and Middle Eastern studies), Stein (cultural anthropology)

A certificate is available in this program.

The program in women's studies at Duke University is dedicated to exploring gender identifications, relations, practices, theories, and institutions. 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, philosophical, economic, representational, technological, and scientific analysis. In our program's dual emphasis on interdisciplinarity and intersectionality, we offer students new knowledge while equipping them with a wide range of analytical and methodological skills.
Many students identify women’s studies courses as among the most exciting and enlightening they take at Duke. The women and men who enroll in our classes each semester gain the opportunity to understand how social, historical, and psychological forces, organized by the central concept of gender, shape them as individuals; attain a fuller understanding of human behavior, culture, and society made possible by investigating women’s lives; acquaint themselves with the experience of women of different economic classes, sexual orientations, and cultural and racial backgrounds; and transfer the critical and analytical skills they acquire in the study of gender and society to other classes, beyond the campus to other activities, and eventually to their professional careers.

Women’s studies has, since its inception, been an interdisciplinary field. It has consistently assessed the strengths and challenges of such interdisciplinarity. Duke students find their background in women’s studies to be a valuable resource for their professional development and lifelong intellectual growth. 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 the Graduate Scholars Colloquium, 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. For additional information, visit the program website at [http://womenstudies.duke.edu](http://womenstudies.duke.edu).

### Requirements for the Graduate Certificate in Feminist Studies

Note: Audited courses do not count toward the certificate; nor does previously taken MA coursework at Duke or elsewhere.

- One required course: Women’s Studies 701S (Foundations in Feminist Theory)
- Two additional (600-level or above) graduate-level courses in or cross-listed with Women’s Studies at Duke (tutorials do not fulfill this requirement).
- A fourth graduate course or tutorial (500-level or above) offered by women’s studies, or another academic unit focusing on women, gender or an intersectional approach to the study of race and/or sexuality (Course must be approved by the DGS.)
- Women, gender, sexuality, or feminism must be a significant aspect of preliminary examination or dissertation project.
- A member of the women’s studies core, secondary, or graduate faculty must be on the preliminary examination and dissertation committees. (A complete listing of our graduate faculty can be found on our website at [http://womenstudies.duke.edu/people](http://womenstudies.duke.edu/people)).

### Courses in Women's Studies (WOMENST)

**501S. History of Sexuality.** 3 units. C-L: see History 501S

**502S. Queer China.** 3 units. C-L: see Asian & Middle Eastern Studies 539S; also C-L: Cultural Anthropology 539S, Literature 539S, Arts of the Moving Image 539S, Visual and Media Studies 539S

**505S. Interethnic Intimacies: Production and Consumption.** 3 units. C-L: see Asian & Middle Eastern Studies 515S; also C-L: Literature 515S, Arts of the Moving Image 515S, Visual and Media Studies 515S, International Comparative Studies 515S

**509S. Race, Class, and Gender: A Social History of Modern (1750-present) Britain.** 3 units. C-L: see History 505S; also C-L: African and African American Studies 515S

**515S. Gender, Identity, and Public Policy.** 3 units. C-L: see Public Policy Studies 530S; also C-L: Political Science 521S

**519S. Topics in Sexuality and Gender Studies.** 3 units. C-L: see Italian 585S

**581S. Masculinities.** 3 units. C-L: see Cultural Anthropology 540S

**590. Topics in Feminist Studies.** Lecture version of WOMEN’S Studies 590S. Instructor: Staff. 3 units.

**590S. Selected Topics in Feminist Studies.** A seminar in contemporary issues, methodology, and/or selected theoretical questions pertaining to feminist scholarship. Instructor: Staff. 3 units.
601S. 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.

611S. Film Feminisms. 3 units. C-L: see Literature 611S

615S. The #Selfie. 3 units. C-L: see Literature 615S; also C-L: Arts of the Moving Image 615S, Visual and Media Studies 615S, International Comparative Studies 615S

701S. 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 761S

730S. Feminist Knowledge, Interdisciplinarity, and Social Change. This course explores feminism as a knowledge formation by considering Women's Studies as a specific interdiscipline, 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. C-L: Literature 761S

740S. 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. C-L: Asian & Middle Eastern Studies 740S

770. 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. C-L: Literature 770

780S. Teaching Race, Teaching Gender. 3 units. C-L: see African and African American Studies 780S; also C-L: History 780S, Literature 780S

795T. Tutorial in Special Topics. Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

796T. Tutorial in Special Topics. Directed research and writing in areas unrepresented by regular course offerings. Consent of instructor required. Instructor: Staff. 3 units.

820S. 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.

860S. Major Figures in Feminist Thought. An examination of the thought of some of the significant figures in history who have been influential in the evolution of feminist thought and theory. These may include Derrida, Irigaray, Foucault, Freud, etc. This course may be taken more than once for credit. Instructor: Staff. 3 units. C-L: Literature 760S

890. Advanced Topics. Lecture version of WOMENST 890S. Instructor: Staff. 3 units.

890S. Advanced Topics in Feminist Studies. A selected topics seminar on emergent theoretical and empirical questions in feminist scholarship. Instructor: Staff. 3 units.

891. Independent Study. 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 an academic and/or artistic product. Consent of Instructor and Director of Graduate Studies required. Instructor: Staff. 3 units.

892S. Publication Workshop. 3 units. C-L: see Literature 892S

960S. Interdisciplinary Debates (Topics). 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.
Other Graduate Level Courses

Following are other graduate level courses that are not part of a specific graduate department or program but nonetheless available for graduate students.

Arts & Sciences IDEAS themes and University Course

Courses in Arts & Sciences themes and University Course (ARTS&SCI)

795. Bass Connections: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing social issues. Teams may also include postdoctoral fellows, visiting fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an ongoing research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

795-1. Bass Connections: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing social issues. Teams may also include postdoctoral fellows, visiting fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an ongoing research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 1.5 units.

796. Bass Connections: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing social issues. Teams may also include postdoctoral fellows, visiting fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an ongoing research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

796-1. Bass Connections: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing social issues. Teams may also include postdoctoral fellows, visiting fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an ongoing research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 1.5 units.

Arts of the Moving Image

Courses in Arts of the Moving Image (AMI)

515S. Interethnic Intimacies: Production and Consumption. 3 units. C-L: see Asian & Middle Eastern Studies 515S; also C-L: Literature 515S, Visual and Media Studies 515S, International Comparative Studies 515S, Women's Studies 505S

539S. Queer China. 3 units. C-L: see Asian & Middle Eastern Studies 539S; also C-L: Cultural Anthropology 539S, Women's Studies 502S, Literature 539S, Visual and Media Studies 539S

561. Anime: Origins, Forms, Mutations. 3 units. C-L: see Asian & Middle Eastern Studies 561

575S. Generative Media Authorship - Music, Text & Image. Covers Generative Media in all its forms. Lectures, workshops, discussions, one semester-length project, shorter individual exercises and readings. Interdisciplinary Graduate Seminar with advanced undergraduates and MFA students with permission of instructor. Instructor: Seaman and Supko. 3 units. C-L: Visual and Media Studies 575S, Information Science and Information Studies 575S, Music 575S

610S. Basic Concepts in Cinema Studies. 3 units. C-L: see Literature 610S

614S. Thinking Digital Cinema. 3 units. C-L: see Literature 614S; also C-L: Theater Studies 671S, Visual and Media Studies 614S
615S. **The #Selfie.** 3 units. C-L: see Literature 615S; also C-L: Visual and Media Studies 615S, Women's Studies 615S, International Comparative Studies 615S

622S. **(Neosentience) Body as Electrochemical Computer.** 3 units. C-L: see Visual Arts 510S; also C-L: Information Science and Information Studies 666S

630. **The Ongoing Moment: Presentations of Time in Still and Moving Images.** 3 units. C-L: see Visual Arts 630

631S. **Phenomenology and Media.** 3 units. C-L: see Literature 630S; also C-L: Art History 630S, Information Science and Information Studies 630S, Visual and Media Studies 630S

632. **Modern Chinese Cinema.** 3 units. C-L: see Asian & Middle Eastern Studies 631; also C-L: Literature 632, Visual and Media Studies 632

633S. **Seminar on Modern Chinese Cinema.** 3 units. C-L: see Asian & Middle Eastern Studies 631S; also C-L: Literature 633S, Visual and Media Studies 633S

640S. **Literary Guide to Italy.** 3 units. C-L: see Italian 586S; also C-L: Literature 542S, German 586S

641. **Documentary and East Asian Cultures.** 3 units. C-L: see Asian & Middle Eastern Studies 511; also C-L: Documentary Studies 511, International Comparative Studies 513

642. **Citizen Godard.** 3 units. C-L: see French 510; also C-L: Visual and Media Studies 552, Literature 510

643S. **Environmental Issues & the Documentary Arts.** 3 units. C-L: see Documentary Studies 615S; also C-L: Environment 615S

644S. **Third Cinema.** 3 units. C-L: see Literature 613S; also C-L: African and African American Studies 530S, International Comparative Studies 613S

690. **Special Topics in Arts of the Moving Image.** Focus on aspects of Arts of the Moving Image. Topics vary. Instructor: Staff. 3 units.

690S. **Special Topics in Arts of the Moving Image.** Focus on aspects of Arts of the Moving Image. Topics vary. 3 units.

691. **Independent Study.** Independent Study. Variable credit.

791. **Independent Study.** Individual work in a field of special interest under the supervision of a faculty member. Goal is a project covering a previously approved topic. Instructor: Gatten. 3 units.

### Asian & Middle Eastern Studies

#### Courses in Asian & Middle Eastern Studies (AMES)

502S. **Translation Studies and Workshop.** 3 units. C-L: see Theater Studies 530S; also C-L: Romance Studies 520S

503. **Asian & Middle Eastern Studies.** Graduate credit for undergraduate course in AMES. Consent of the instructor and the director of undergraduate studies required. Instructor: Staff. 3 units.

503S. **Asian & Middle Eastern Studies.** Graduate credit for undergraduate course in AMES. Consent of the instructor and the AMES DGS required. Instructor: Staff. 1 unit.

504S. **East Asia's Twentieth Century.** 3 units. C-L: see History 504S

505S. **Seminar in Asian and Middle Eastern Cultural Studies.** Concentration on a theoretical problem or set of issues germane to the study of Asian and Middle Eastern cultures. 3 units. C-L: African and African American Studies 540S, Literature 530S

511. **Documentary and East Asian Cultures.** Focus on documentary films from various regions in East Asia, including China, Taiwan, Korea and Japan, studying the specific historical and social context of each while attending to their interconnected histories and cultures. Emphasis on the ethical implications of documentary in terms of its deployment of visual-audio apparatus to represent different groups of people and beliefs, values and conflicts, both intra- and inter-regionally in East Asia. Special attention paid to the aesthetics and politics of the documentary form in terms of both its production of meanings and contexts of reception. Instructor: Hong. 3 units. C-L: Arts of the Moving Image 641, Documentary Studies 511, International Comparative Studies 513
515S. Interethnic Intimacies: Production and Consumption. Critical examination of cultural dynamics, political economies, and ethical implications of interethnic intimacies or "intercourse" as represented from and about Asia. Examines shifts within and beyond "Asia", asking why cultural representations matter in ways societies construct, produce, and consume objects of desire and repulsion. Texts from literature and visual culture read along with theories of critical race studies, gender and sexuality, postcolonialism, globalization, visual culture, and other representative technologies of the Self/Other. May be taught simultaneously with AMES 415S with additional requirements. Students who have taken the freshman seminar are not eligible. Instructor: Kwon. 3 units. C-L: Literature 515S, Arts of the Moving Image 515S, Visual and Media Studies 515S, International Comparative Studies 515S, Women's Studies 505S

526A. Religion and Civil Society in the Arab World. Examine how the Arab world is embodied in world system of the 21st century. Learn the specific accents that inform its citizens and shape its prospects locally, regionally and internationally. Examine how the major Abrahamic traditions — Judaism, Christianity and Islam — had their historical origins in the eastern Mediterranean world, and how they continue to have adherents that populate the region and challenge the modern notion of citizenship. Explore how the current uprising reflects the challenges of reconciling local aspirations with global forces. Class content is similar to AMES 326A with added reading materials, meeting hours and assignments. STUDY ABROAD: Duke in the Arab World. Instructor: Lo & McLarney. 3 units. C-L: Religion 526A

529S. Gender Jihad: Muslim Women Writers. Roles and representations of women in Muslim societies of Asia (including Indonesia, South Asia, and the Middle East) and Africa, as well as in Muslim minority societies (including Europe and the United States). Examination of ways writers and filmmakers project images of women in today's Muslim societies. Focus on women as producers of culture and as social critics. Same as AMES 173S but requires extra assignments. Staff: Cooke. 3 units.

533. Traffic in Women: Cultural Perspectives on Prostitution in Modern China. Dialectic of prostitution as lived experience, and as socio-cultural metaphor. Focus on literary and cinematic texts, together with relevant theoretical works. The figure of the prostitute will be used to interrogate assumptions about gender identity, commodity value, and national discourse. Transnational traffic in women will provide context for examination of discourses of national identity in China and beyond, together with the fissures at the heart of those same discourses. Same as Asian and Middle Eastern Studies 333 but with additional graduate level work. Instructor: Rojas. 3 units.

535. Chinese Media and Pop Culture. Current issues of contemporary Chinese media and popular culture within the context of globalization. Cultural politics, ideological discourse, and intellectual debates since gaige kaifang (reform and opening up); aspects of Chinese media and popular culture: cinema, television, newspapers and magazines, the Internet, popular music, comics, cell phone text messages, and fashion. Instructor: Liu. 3 units. C-L: Information Science and Information Studies 535

539S. Queer China. Examines queer discourses, cultures, and social formations in China, Greater China, and the global Chinese diaspora from the late imperial period to the present. Course will focus on cultural representations, particularly literary and cinematic, but will also consider a wide array of historical, anthropological, sociological, and theoretical materials. Not open to students who have taken Asian and Middle Eastern Studies 439. Instructor: Rojas. 3 units. C-L: Cultural Anthropology 539S, Women's Studies 502S, Literature 539S, Arts of the Moving Image 539S, Visual and Media Studies 539S

540S. Reading Heidegger. Closely reading major works by Heidegger Tracing the Turn in Heidegger's thought from the early metaphysical writing to the lecture courses of the 1930s. Underscores the role played by language in Heidegger's thought Probes what aesthetics means within the context of Heidgger's work. Instructor: Ginsburg. 3 units. C-L: Literature 543S, Religion 560S

541S. Jews and the End of Theory. Examines role played by the figure of "the Jew" (or "Jews") in critical theory. Assesses role played by Jewish "giants" in shaping critical theory. Explores role played by images of Jews and Jewishness in linguistic turn of 20th century theory. Asks how should one understand contemporary theory in relation to "Jews"—literal Jews and figurative Jews, whether demise of these intellectual giants and diminishing interest in "Jews" and "Jewishness" means "the end of theory", and how to conceive the relations between theory and "Jewish Studies" in light of these questions. Instructor: Ginsburg. 3 units. C-L: Jewish Studies 541S, Literature 580S, International Comparative Studies 541S
552S. Epics of India: Ethics, Politics, and Performance Traditions. 3 units. C-L: see Religion 562S

555. Contemporary Culture in South Asia. Same as Asian and Middle Eastern Studies 355. Instructor: Staff. 3 units.


563S. Nightmare Japan. Inquiry into social anxieties erupted through encounters with natural or man-made "disasters." Examine defining disasters of modern Japan—the encounter with the West, the imperialist war and subsequent defeat, nuclear bomb and the recent Fukushima meltdowns, earthquakes and tsunami, recession and its associated social malady. Reading through literature, films and popular culture as sites where fantasy and desire are materialized and projected in coping with these ineluctable catastrophes. Same as Asian and Middle Eastern Studies 463S but with additional readings, assignments and meeting times. Instructor: Ching. 3 units. C-L: Cultural Anthropology 563S

565. The World of Japanese Pop Culture. An examination of modern Japanese culture through a variety of media including literary texts, cultural representations, and films. Different material each year; may be repeated for credit. (Same as Asian and Middle Eastern Studies 365 but requires extra assignments.) Instructor: Ching. 3 units. C-L: Cultural Anthropology 565

590. Special Topics in Asian and Middle Eastern Studies. Topics vary each semester. Instructor: Staff. 3 units.

593. 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. 3 units.

603. The Palestinian-Israeli Conflict in Literature and Film. A cultural study of the collapse of the Israeli-Palestinian peace process and failure of Israeli and Palestinian doves to transform their respective communities and to change conditions on the ground. Focus on self-criticism as manifested in Israeli and Palestinian literature and cinema and on its limits. Instructor: Staff. 3 units. C-L: Jewish Studies 683

605. East Asian Cultural Studies. East Asia as a historical and geographical category of knowledge emerging within the various processes of global movements (imperialism, colonialism, economic regionalism). Instructor consent required. Instructor: Ching. 3 units. C-L: Cultural Anthropology 605, Literature 571, International Comparative Studies 605

610S. Trauma and Space in Asia. Space and Trauma across Asia. Introduces theoretical framework of "trauma discourse;" examines how the experience of space in Asia broadly defined has shaped historical traumas, which have marked the transition from colonialism to postcolonialism. Focus on Israel/Palestine, India/Pakistan, China/Taiwan, Japan/Korea; examines how critical terms originating in one historico-geographical context are translated across geographical boundaries. Taught simultaneously with AMES 410, but includes additional readings, assignments, and meeting times. Instructor: Kwon, Ginsburg. 3 units.

611. Melodrama East and West. Melodrama as a genre in literature and as a mode of representation in film and other media. Issues include: gender construction, class formation, racial recognition, and national identity-building. Emphasis on comparative method attending American and Chinese cultures and the politics of cross-cultural representation. (Same as Asian and Middle Eastern Studies 411 but requires extra assignments.) Instructor: Hong. 3 units.

620S. Critical Genealogies of the Middle East: An examination of the canon of Middle East scholarship. This course provides an in-depth investigation into the various theoretical and textual traditions that inform interdisciplinary Middle East studies with a focus on History, Cultural Studies, Religion and Social Sciences. Interdisciplinary in scope, the course will maintain a disciplinary rigor so that students learn how knowledge is produced within the framework of specific disciplines. Foci include social history, literary theory, critical visual studies, and postcolonial theory. Staff: Cooke. 3 units.

622S. Arab Women Writers. The emergence of women writers in the Arab world from nineteenth century poets to 21st century bloggers. Novels, short stories, autobiographies and poetry dealing with Arab women's rights in the
Asian & Middle Eastern Studies

Home and in politics, war, colonialism, religion and sexuality. Writers include Syrian Idilbi and Samman, Egyptian El Saadawi and Bakr, Lebanese al-Shaykh, Palestinian Khalifa, Iraqi Riverbend, Algerian Djebbar. Same as Asian and Middle Eastern Studies 422S but with additional graduate level work. Instructor: Cooke. 3 units.

623. Arabic Culture and 9/11. Same as Asian and Middle Eastern Studies 423 except 623 has additional focus on theoretical studies of cultural production of the post-1990 period including such works as Shohat and Stam, Unthinking Eurocentrism, and Abdelwahhab Meddeb, The Malady of Islam. Instructor: Cooke. 3 units.

625. Islamic Awakening: Revival and Reform. Explores religious revival in the Islamic world: revival as reinterpretation of sacred texts, revival as revolution, revival as social movement, revival as spiritual awakening, revival as political mobilization, revival as cultural renaissance. Graduate students will pursue in depth research in their specific area of concentration, read selected sources in the original languages, and design a final project that furthers their course of study. Instructor: McLarney. 3 units.

629. Revolution: The Arab World. Revolution in the Middle East and the Arab world, with focus on Tunis, Syria, and Egypt: revolution in theory and practice; studying events as they unfold in real time; histories of revolution in the region; democratic mobilization against authoritarian regimes; religion and revolution; media, social media, and social change; the poetics of politics; graffiti art; and women's political action. Graduate level includes readings and research in Arabic, or any other primary source readings in original language of graduate students' area of specialty, more extensive theoretical readings, a substantive research paper, and regular group meetings with instructors to discuss extra readings. Instructor: McLarney, Cooke. 3 units.

629S. Muslim Networks Across Time and Space. Muslim networks are at once an historical and a contemporary phenomenon. Networks for the exchange of material goods, people and cultural practices define Islamic civilization, and now the Internet provides a new network of communication in cyberspace. This course will explore various hermeneutical strategies for understanding both Muslim cybernauts and their role in the future of Muslim communities from America to Asia. Instructor: Cooke, Lawrence. 3 units. C-L: Religion 662S.

631. Modern Chinese Cinema. Films, documentaries, television series, and soap operas produced in mainland China in the post-Mao era. Topics include the history and aesthetics of the cinema, soap operas as the new forum for public debates on popular culture, the emerging film criticism in China, the relationship of politics and form in postrevolutionary aesthetics. (Same as AMES 431 but requires extra assignments.) Research paper required. Prerequisites: Chinese 436S or advanced oral and written proficiency in Mandarin Chinese. Instructor: Hong. 3 units. C-L: Arts of the Moving Image 632, Literature 632, Visual and Media Studies 632.

631S. Seminar on Modern Chinese Cinema. Films, documentaries, television series, and soap operas produced in mainland China in the post-Mao era. Topics include the history and aesthetics of the cinema, soap operas as the new forum for public debates on popular culture, the emerging film criticism in China, the relationship of politics and form in postrevolutionary aesthetics. (Same as AMES 431 but requires extra assignments.) Research paper required. Instructor consent required. Prerequisite: Chinese 436S or advanced oral and written proficiency in Mandarin Chinese. Instructor: Hong. 3 units. C-L: Arts of the Moving Image 633S, Literature 631S, Visual and Media Studies 631S.

632S. Literati/Literature Culture: Pre Modern Chinese Literature. Survey of works in Chinese from Confucius to the Qing Dynasty including short stories, novels, autobiographical writings, and poetry. Topics include the role of the educated elite in relation to literature and culture and how the literati portray themselves in their works. Relations between orthodoxy and marginalization of the literati and its impact on their writing. (Same as Asian and Middle Eastern Studies 432S but requires extra assignments.) Instructor: Staff. 3 units.

650S. Human Rights in Islam. Islamic conceptions of human rights, beginning with early formulations of key concepts like freedom and equality during the Arab “awakening” or Nahda and continuing to Islamic conceptions of rights after WWII and the Universal Declaration of Human Rights. Special attention to how women’s rights and women's emancipation became key points of dispute between the West and the Islamic world. How ideas of the human and humanity (and its “rights”) are constructed, especially within the humanities. Same as 450S, but with graduate level assignments and discussions. Instructor: McLarney. 3 units. C-L: Religion 661S.

661. Japanese Cinema. An introduction to the history of Japanese cinema focusing on issues including the relation between the tradition-modernity or Japan-West in the development of Japanese cinema, the influence of Japanese films on the theory and practice of cinema abroad, and the ways in which cinema has served as a reflection of and an
active agent in the transformation of Japanese society. (Same as Asian and Middle Eastern Studies 461, but requires extra assignments.) Instructor: Chow. 3 units.

665. Girl Culture, Media, and Japan. Examination, through visual and literary texts, of the way in which girlhood, girl culture, and girl bodies have figured in the construction of gender, nation, and consumer culture in modern to contemporary Japan. Same as Asian and Middle Eastern Studies 465, but requires extra assignments. Instructor: Staff. 3 units.

669S. Minor Japan. Examine the history and experiences of marginalized peoples in Japan from the Ainu to ethnic Koreans, from queer to the Okinawans, to challenge the myth of racial and ethnic homogeneity and sexual heteronormativity. Enhance understanding about cultural and artistic productions by reading a variety of texts, including fiction, oral histories, philosophical treatises, and films. Same as Asian and Middle Eastern Studies 469S, with extra graduate level assignments, discussion groups, and papers. Instructor: Ching. 3 units.

671. World of Korean Cinema. Introduction to Korean Cinema from postwar to contemporary period. Examination of issues such as national division, gender, pop culture, family, transnational identity and its influence abroad. Same as Asian and Middle Eastern Studies 471, but requires extra assignments. Instructor: Staff. 3 units.

673. Trauma and Passion in Korean Culture. Representations of passion and trauma in Korean society and history through various cultural media including literature, historical texts, autobiographies, film, and other visual media. In dealing with historical traumas such as the Korean War, Japanese colonization, Western imperialism and political upheavals, sub-topics to include war, love, melodrama, nationalism, ideological strife and longing and loss. (Same as Asian and Middle Eastern Studies 473 but requires extra assignments.) Instructor: Kwon. 3 units.

682. Arabian Nights in the West. Graduate version of Asian and Middle Eastern Studies 482. Examines one of the most popular works of world literature, The Thousand and One Nights. Considers elements of fairy tales, romances, fables, legends, parables, and adventures. Comparison of narrative techniques used in Boccaccio's The Decameron and Chaucer's Canterbury Tales. Comparative analysis of the structure of the story. Students in this graduate section will have a supplementary reading list, additional assignments, and meet regularly with the professor outside regular class time. Instructor consent required. Instructor: Jawad Al Mamouri. 3 units.

690S. Special Topics in Asian and Middle Eastern Studies. Seminar version of Asian and Middle Eastern Studies 590. Topics vary each semester. 3 units.

695. Collaborative Research Projects. Small collaborative research projects of faculty with graduate and undergraduate students. Close mentoring of students. Training in methods of cultural analysis and interpretation. Projects developed in conjunction with ongoing faculty initiatives. Students will present their research in the form of a term paper or some equivalent medium. Funding available to support students' research. Director of Graduate Studies consent required. Instructor: Staff. 3 units.

720. Professionalization Workshop in Middle East Studies. This bi-weekly professionalization workshop held alternately at Duke and UNC prepares students for a career in Middle East Studies. It is tailored to the interests of enrolled students who may suggest readings for discussion and present their own work. Instructor: Cooke. 1 unit.

738. Theories of Minority Discourse. Course will introduce a variety of critical theories of minority discourse, or discourses associated with minority groups within a more dominant cultural tradition. Course will also consider examples of these sorts of texts, focusing primarily on works from within a Chinese or Greater Chinese cultural sphere. Knowledge of Chinese encouraged, but not required. Instructor: Rojas. 3 units.

740S. Critical Genealogies. 3 units. C-L: see Women's Studies 740S

Courses in Arabic (ARABIC)

501S. Translation as a Research Tool in Arabic and Islamic Studies. Introduces advanced students of Arabic to the science of translation as a major tool to pursue research in Arabic and Islamic studies. Learn techniques of translating Arabic text, editing, accessing biographical translation. Teach students how to translate literary text, religious text etc. (Qur'an, Hadith, poetry, etc.) Instructor: Jaward. 3 units.

690. SPECIAL READINGS. Variable credit.

789. Classical Arabic Language & Literature. Explore the development of Arabic language and Literature from the pre-Islamic era to the current epoch. Review major Arabic works in each of the Islamic eras. Explore the role of
the Qur’an in the construction of Arabic sciences. Examine a variety of classical texts within the context of each era. Review the content and forms of essential texts of the science of Islamic Studies, including tafsir (Qur’anic exegesis), sirah (biography of the Prophet Muhammad), Hadith, travel literature, biographical literature. The graduate and undergraduate sections will be taught together with extra expectations and additional assignments for the graduate students. Instructor: Lo. 3 units.

791. Independent Study. Individual study of language for conducting research involving sources written or spoken in the language. Students have to submit a proposal describing the purported research, types of sources to be analyzed, and kinds of language knowledge or skills they need to be equipped with. Consent of instructor and director of undergraduate studies required. Instructor: Staff. 3 units.

Courses in Chinese (CHINESE)
791. Independent Study. Individual study of language for conducting research involving sources written or spoken in the language. Students have to submit a proposal describing the purported research, types of sources to be analyzed, and kinds of language knowledge or skills they need to be equipped with. Consent of instructor and director of undergraduate studies required. Instructor: Staff. 3 units.

Courses in Hebrew (HEBREW)
791. Independent Study. Individual study of language for conducting research involving sources written or spoken in the language. Students have to submit a proposal describing the purported research, types of sources to be analyzed, and kinds of language knowledge or skills they need to be equipped with. Consent of instructor and director of undergraduate studies required. Instructor: Staff. 3 units.

Courses in Hindi (HINDI)
791. Independent Study. Individual study of language for conducting research involving sources written or spoken in the language. Students have to submit a proposal describing the purported research, types of sources to be analyzed, and kinds of language knowledge or skills they need to be equipped with. Consent of instructor and director of undergraduate studies required. Instructor: Staff. 3 units.

Courses in Japanese (JPN)
650. Research Methods in Japanese (B). Introduction to various research approaches to literary, sociological, and historical studies of Japan. Emphasis on bibliographical sources that best serve needs in chosen area of specialization. Consent of instructor required. Instructor: Staff. 3 units. C-L: History 503, Sociology 664

771S. Classical Japanese (Bungo). Introduction to classical Japanese (Bungo). Readings in ancient, medieval, early modern, and modern texts, prose and poetry, such as Hōjōji, Shinkokinshu, Oku no hosomichi, Hyakunin isshu, Genjō kōan, and Gakumon no susume. Emphasis on understanding classical grammar and translation of texts. Japanese 771S is same as Japanese 471S with extra assignments for the graduate students. Prerequisite: Japanese 408S or permission of instructor. Instructor: Tucker. 3 units.

772S. Classical Japanese (Kanbun). Introduction to Sino-Japanese (kanbun). Readings in early modern Japanese Confucian and Buddhist texts as well as Chinese Confucian, Daoist, Mohist, Legalist, and Buddhist texts. Emphasis on understanding reading order (yomikudashi), classical Japanese grammar (bungo), and translation of texts. Japanese 772S is same as Japanese 472S with extra assignments for the graduate students. Prerequisite: JPN 471S, 771S or permission of instructor. Instructor: Tucker. 3 units.

791. Independent Study. Individual study of language for conducting research involving sources written or spoken in the language. Students have to submit a proposal describing the purported research, types of sources to be analyzed, and kinds of language knowledge or skills they need to be equipped with. Consent of instructor and director of undergraduate studies required. Instructor: Staff. 3 units.

Courses in Korean (KOREAN)
791. Independent Study. Individual study of language for conducting research involving sources written or spoken in the language. Students have to submit a proposal describing the purported research, types of sources to be analyzed, and kinds of language knowledge or skills they need to be equipped with. Consent of instructor and director of undergraduate studies required. Instructor: Staff. 3 units.
Courses in Sanskrit (SANSKRIT)

701. Introductory Sanskrit Language and Literature I. Introduces classical, literary Sanskrit, the ancient and trans-continental language of India’s intellectual heritage, history, and sacred scriptures. Teaches students Devanagari script, to learn and analyze grammatical forms and structures, vocabulary, and to interpret meaning. Provides an overview to the literature and civilizational importance of Sanskrit, from the ancient past to the present. Course will give graduate students the grammatical and analytic tools they will need to begin to read and interpret original texts. Instructor: Freeman. 3 units. C-L: Religion 707

702. Introductory Sanskrit Language and Literature II. Continuation of SANSKRIT 701/RELIGION 707 as prerequisite. Further learning of grammatical forms and structures of the higher language. Introduction of elementary readings from literature and scriptures. Introduces graduate students to the various genres of the language and a variety of styles they are likely to encounter in their research. Instructor: Freeman. 3 units. C-L: Religion 708

803. Intermediate Sanskrit. Selected readings in literature and scriptures, with introduction to the conventions of traditional literary forms, grammar, and interpretation. In addition, it provides departure point for graduate students to become familiar with literary, philosophical, and commentarial forms that they will need to comprehend for undertaking primary research in the language. Can lead to continuation in specialized reading courses or Independent Studies. Prerequisite: SANSKRIT 702/RELIGION 708. Instructor: Freeman. 3 units. C-L: Religion 809

Dance

Courses in Dance (DANCE)

535S. AfroFuturism. 3 units. C-L: see African and African American Studies 620S; also C-L: Theater Studies 535S, Visual and Media Studies 524S

545S. Selected Topics in Dance Theory. Topics vary. Instructor: Staff. 3 units.

645S. Black Performance Theory. 3 units. C-L: see African and African American Studies 621S; also C-L: Visual and Media Studies 621S

Documentary Studies

Courses in Documentary Studies (DOCST)

511. Documentary and East Asian Cultures. 3 units. C-L: see Asian & Middle Eastern Studies 511; also C-L: Arts of the Moving Image 641, International Comparative Studies 513

611. Documentary Writing Workshop. Workshop in the art and practice of writing in the long-form traditions of narrative nonfiction, literary journalism, and documentary writing. Write, share, and refine one major work of narrative nonfiction throughout the semester. Discuss research methods and resources, especially those useful for creative writers. Intended for advanced writers who would like to work on ambitious nonfiction work in an intensely creative and supportive workshop. Instructor: Murrell. 3 units.

615S. Environmental Issues & the Documentary Arts. Survey how filmmakers, authors, photographers, and other artists have brought environmental issues to the public's attention in the last century, and in some cases instigated profound societal and political change. Examine the nebulous distinctions between persuasion and propaganda, agenda and allegory, point of view and content. Evolve as a viewer of the environment and a maker of documentary art. Initiate your own projects to address and/or depict environmental issues in one form of a broad range of media. Instructor: Espelie. 3 units. C-L: Environment 615S, Arts of the Moving Image 643S

705S. The Documentary Experience: A Video Approach (A). A documentary approach to the study of local communities through video production projects assigned by the course instructor. Working closely with these groups, students explore issues or topics of concern to the community. Students complete an edited video as their final project. Not open to students who have taken this course as Film/Video/Digital 105S. Consent of instructor required. Instructor: Hawkins. 3 units.

710S. **The Short Audio Documentary.** Introductory to intermediate audio techniques. Includes instructor-supervised fieldwork with an audio recorder in a variety of settings using creative approaches; students produce four short pieces (roughly three minutes long) in varying styles (journalistic, personal, artistic) for posting on iTunes and on public multimedia websites. Consent of instructor required. Instructor: Biewen. 3 units.

720S. **Freedom Stories: Documenting Southern Lives and Writing.** Documentary writing course focusing on race and storytelling in the South, using fiction, autobiography, and traditional history books. Producing narratives using documentary research, interviews, and personal memories. Focus on twentieth-century racial politics. Instructor: Tyson. 3 units.

724S. **Children's Self Expression: Literacy Through Photography.** Children's self-expression and education through writing, photograph and documentary work. Focus on reading and critical interpretation of images. The history, philosophy, and methodology of Literacy Through Photography. Includes internship in an elementary or middle school classroom. Required participation in service learning. Consent of instructor required. Instructor: Hyde. 3 units.

735S. **Introduction to Audio Documentary.** Recording techniques and audio mixing on digital editing software for the production of audio (radio) documentaries. Various approaches to audio documentary work, from the journalistic to the personal; use of fieldwork to explore cultural differences. Stories told through audio, using National Public Radio-style form, focusing on a particular social concern such as war and peace, death and dying, civil rights. Instructor: Biewen. 3 units.

736S. **Color Photography: Fieldwork and Digital Color.** Field-based course examining color photography as a documentary tool. Students learn about aesthetic and technical foundations of color photography using recent digital technology. Class-conducted intensive examination of the work of historic and contemporary color documentary photographers. Advanced techniques in film scanning, Photoshop, and color pigment printing using Arts Warehouse multimedia classroom. Completion of semester-long color photographic project, and final project consisting of production of a series of color pigment prints. Consent of instructor required. Instructor: Harris. 3 units.

741S. **Politics of Food: Land, Labor, Health, and Economics.** Explores the food system through fieldwork, study, and guest lectures that include farmers, nutritionists, sustainable agriculture advocates, rural organizers, and farmworker activists. Examines how food is produced, seeks to identify and understand its workers and working conditions in fields and factories, and, using documentary research conducted in the field and other means, unpacks the major current issues in the food justice arena globally and locally. Fieldwork required, but no advanced technological experience necessary. At least one group field trip, perhaps to a local farm or farmers market, required. Instructor: Thompson. 3 units.

744S. **Our Culinary Cultures.** Documentary approach to the world of food using fieldwork research. Topics of food and its preparation examined through deep stories of how food is raised, prepared, and presented in order to explore how the myriad ways in which what we eat reveal key biographical, economic, religious, and other truths about our cultures. Introduces students to the history of food writing and the concept of food in general as a nonverbal tool of communication. Photography, audio, and documentary writing employed. Instructor: Alexander. 3 units.

745S. **Photography in Context.** Uses the Duke Library Photography Archive as a resource to challenge students to think critically about photography. Considers how photography offers insights into areas of academic study such as social change, sexual identity, and regional culture, and how images have shaped collective understanding of these issues. Focuses on analyzing and contextualizing bodies of photographic work, the historical moment in which the pictures were made, personal history and artistic sensibility of the photographer, tools of the medium, along with considering personal responses to images and the ways in which all factors come together. Instructor: Sartor. 3 units.

750S. **Documentary Engagement Through Field-Based Projects.** Documentary photography as a tool for social engagement in preparation for intensive field-based projects. Students study documentary photographers while planning and refining their own documentary projects through which they will address societal issues locally, nationally, or abroad. Students learn and refine valuable technical skills such as Photoshop, inkjet printing, and web-based methods in order to complete a preliminary documentary project by the end of the semester. Consent of instructor required. Required participation in service learning. Instructor: Harris. 3 units.

752S. **Documentary Publishing from Gutenberg to the Web: History and Practice.** Publishing course leading to the publication of a digital documentary magazine; grounded in cultural, technical, and aesthetic history of
documentary periodicals, from 16th century Venetian avvisi through the 18th century English gentlemen's magazines through the mid 20th century "Golden Age" of American magazines, to the current age of the digital documentary publication; speakers and advisors from the publishing industry and the Center for Documentary Studies; wide readings in the international history of periodicals and documentarism; production of a digital magazine conceived, created, edited, designed and built by students in accordance with professional standards and practices. Instructor: Murrell. 3 units.

760S. Multimedia Documentary: Editing, Production, and Publication. Edit and shape fieldwork material into a Web-based multimedia presentation. Learn current technologies and techniques for multimedia publications. Examine unique storytelling strategies for on-line presentations and compare this medium to traditional venues for documentary work such as exhibitions, books, and broadcast. Instructor: Sims. 3 units.

775S. The Documentary Essay: Exploration, Research, and the Peripatetic Tradition in Documentary Writing. Writing workshop course exploring the intersection of documentary fieldwork methods and the exploratory traditions and practices of the essay. Grounded in the recognition that the documentary essay engages the world first, seeking knowledge and understanding, gathers the material of art by direct experience. Out-of-class exploration emphasized through careful exploration of the special collections of Duke University; and by pursuing a common subject as a class. Wide readings in documentary essays, workshop discussion of student work, and the eventual goal of publication in the new CDS student documentary magazine. This is a graduate level pairing with 112S. Instructor: Murrell. 3 units.

790S. Advanced Special Topics in Documentary Studies. Advanced selected topics in methodology, theory, or area in seminar format. Instructor: Staff. 3 units.

Education

Courses in Education (EDUC)

514. Technology, Society, and Schools. Role of technology in schools and society. Introduction for preservice teacher candidates to technology tools including Photoshop, web design, and digital storytelling. Emphasis on integrating technology into instruction and utilizing technology to become educational leaders. Includes elements of design through completion of online portfolio. Designed to meet the North Carolina Department of Public Instruction technology requirements for teaching licensure. Consent of instructor required. Instructor: Crumley. 2 units.

542S. Schooling and Social Stratification. 3 units. C-L: see Public Policy Studies 542S; also C-L: African and African American Studies 549S

620. Nature and Needs of the Gifted Learner: Introduction to Characteristics and Educ/Affective Needs. Introduction to characteristics and unique educational and affective needs of gifted learners. Analysis of philosophical considerations, historical perspectives, definitions and types of giftedness, incidence, and evaluation procedures. Cultural comparisons of the manifestations of giftedness, ways of reversing underrepresentation of minority students in programs for the gifted, and affective social-emotional topics/issues relating to giftedness. This course is a post-bacc, non-degree course not open to Duke undergraduates. Consent of instructor required. Instructor: Staff. 3 units.

622. Differentiating Curriculum for the Gifted Learner: Program Planning and Curriculum Development. Organize and deliver appropriate curriculum for gifted and talented students. Focus on program planning, exemplary program models, development of differentiated curriculum with appropriate modifications to content, process, product and learning environment. Instructor: Staff. 3 units.

623. Practicum and Seminar in Gifted Education. Supervised practicum with gifted learners in a differentiated education program. Students plan, develop, and evaluate educational experiences, with a special emphasis on the social and emotional development of gifted learners. Instructor consent required. Instructor: Staff. 3 units.

651. Directed Activities. Internship experiences at an advanced level under supervision of appropriate staff. Prerequisite: consent of instructor. Instructor: Staff. 3 units.

690S. Selected Topics Seminar. May be repeated. Consent of instructor required. Instructor: Staff. 3 units.

791. Graduate Independent Study. Directed readings in a field of special interest under the supervision of a faculty member, the central goal of which is a substantive paper or project on a previously approved topic at the graduate level. Instructor: Staff. 1 unit.
794S. Research Synthesis and Meta-Analysis (G). Recent developments in research synthesis in the behavioral and medical sciences. Topics include: problem formulation; scientific communication; methods for locating research; problems in retrieving data from secondary sources; judging the quality of research; effect size estimation; analyzing variance in effect sizes across studies. Prerequisites: Statistics through analysis of variance. Consent of instructor required. Instructor: Cooper. 3 units. C-L: Psychology 769S

**Energy**

**Courses in Energy (ENERGY)**

520. Resource & Environmental Economics I. 1.5 units. C-L: see Environment 520; also C-L: Economics 530, Public Policy Studies 576

524. Water Quality Health. 3 units. C-L: see Earth and Ocean Sciences 524; also C-L: Environment 524, Global Health 534

590S. Advanced Topics in Energy. Selected topics vary by semester. Instructor: Staff. 3 units.

630. Transportation and Energy. 3 units. C-L: see Environment 630

635. Energy Economics and Policy. 1.5 units. C-L: see Environment 635

638L. Environmental Life Cycle Analysis & Decision. 3 units. C-L: see Environment 638L

711. Energy and Environment. 3 units. C-L: see Environment 711

716L. Modeling for Energy Systems. 3 units. C-L: see Environment 716L

727. Energy Law. 3 units. C-L: see Law 327

790. Meeting the Needs of 1.2 Billion People Who Lack Access to Power. One of the great challenges of our time is the need to bring electric power to the 1.2 billion people in the world who lack it. This graduate seminar will explore the challenges between rural and urban systems, and the technologies that can solve the issues of each situation. We will also investigate the impediments to progress, and explore the different business models and technologies that are being used to tackle the challenge. The class will culminate by asking students to help design the most appropriate model for deploying power technologies in a range of world regions, and build upon Rogers' investigation of this topic in his role as a University Fellow. Instructor: Profeta. 3 units.

795. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

795-1. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 1.5 units.

796. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

796-1. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may
also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 1.5 units.

811. Sustainable Systems Theory and Drivers. 3 units. C-L: see Environment 811

835. Environmental Law. 3 units. C-L: see Environment 835

891. Topics in Environmental Regulation. 1.5 units. C-L: see Environment 891

Ethics

Courses in Ethics (ETHICS)

561. History of Poverty in the United States. A history of poverty and poverty policy in the United States from the colonial era to the present. The changing experience of poverty, efforts to analyze and measure poverty, and attempts to alleviate or eliminate it. Attention paid to the reasons for the durability of poverty in a wealthy nation and to the forces shaping the contours of anti-poverty policy. Instructor: Staff. 3 units. C-L: History 546, Public Policy Studies 528

562S. Understanding Ethical Crisis in Organizations. This course examines the causes and consequences of ethical crisis across business, military, higher education and religious institutions. Emphasis is on identifying why certain organizations are more prone to ethical problems and certain organizations better able to manage them. A core goal is to develop real-world solutions to ethical challenges organizations face in contemporary societies worldwide. Instructor: Pickus. 3 units. C-L: Political Science 502S, Sociology 542S, Public Policy Studies 558S

590S. Special Topics in Ethics. Topics vary. Instructor: Staff. 3 units.

Genome Sciences and Policy

Courses in Genome Sciences and Policy (GENOME)

508S. Global Health and Genomics. 3 units. C-L: see Global Health 510S

584. Genetics and Reproductive Technologies. 2 units. C-L: see Law 584

590S. Special Topics in Genome Sciences. Topics will vary. Instructor: Staff. 3 units.

612. Ethics and Policy in 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: (1) 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: Chandrasekharan. 3 units. C-L: Public Policy Studies 634, Computational Biology and Bioinformatics 612

627. Molecular Ecology. 3 units. C-L: see Environment 627; also C-L: Biology 627

641S. Cancer in Our Lives: Film, Narrative, Fiction, History and Politics. 3 units. C-L: see Public Policy Studies 641S

799S. Topics in Ecological Genomics. 1 unit. C-L: see Environment 799S

International Comparative Studies

Courses in International Comparative Studies (ICS)

505S. Race in Comparative Perspective. 3 units. C-L: see Political Science 505S

506. Politics of United States Foreign Policy. 3 units. C-L: see Public Policy Studies 506; also C-L: Political Science 547

510S. Africa in a Global Age. 3 units. C-L: see Cultural Anthropology 561S; also C-L: African and African American Studies 510S, History 561S, Political Science 527S

511S. Political Participation: Comparative Perspectives. 3 units. C-L: see Political Science 509S
512S. Current Issues in International and Development Economics. 3 units. C-L: see Economics 568S
513. Documentary and East Asian Cultures. 3 units. C-L: see Asian & Middle Eastern Studies 511; also C-L: Arts of the Moving Image 641, Documentary Studies 511
514S. Assisting Development. 3 units. C-L: see Public Policy Studies 515S; also C-L: Political Science 546S
515S. Interethnic Intimacies: Production and Consumption. 3 units. C-L: see Asian & Middle Eastern Studies 515S; also C-L: Literature 515S, Arts of the Moving Image 515S, Visual and Media Studies 515S, Women's Studies 505S
521S. International Environmental Regimes. 3 units. C-L: see Political Science 545S; also C-L: Public Policy Studies 581S
525S. Culture, Power, History. 3 units. C-L: see Cultural Anthropology 525S
527S. Music in Literature and Philosophy. 3 units. C-L: see German 580S; also C-L: English 580S
529S. Race and Ethnicity. 3 units. C-L: see Public Policy Studies 529S; also C-L: African and African American Studies 551S
531S. Camera Asia. 3 units. C-L: see Visual and Media Studies 535S; also C-L: History 530S
537S. Post War Europe, 1945-1968: Politics, Society, and Culture. 3 units. C-L: see History 537S; also C-L: Political Science 515S
541S. Jews and the End of Theory. 3 units. C-L: see Asian & Middle Eastern Studies 541S; also C-L: Jewish Studies 541S, Literature 580S
543S. Maritime Predation and European Imperial Expansion in the Atlantic Basin, 1492-1730. 3 units. C-L: see History 543S
561. 9/11: Causes, Response & Strategy. 3 units. C-L: see Public Policy Studies 561; also C-L: Political Science 544
577. Environmental Politics. 3 units. C-L: see Environment 577; also C-L: Public Policy Studies 577
580S. Water Cooperation and Conflict. 3 units. C-L: see Public Policy Studies 580S; also C-L: Global Health 533S, Environment 543S
598. Economic Growth and Development Policy. 3 units. C-L: see Public Policy Studies 598
605. East Asian Cultural Studies. 3 units. C-L: see Asian & Middle Eastern Studies 605; also C-L: Cultural Anthropology 605, Literature 571
613S. Third Cinema. 3 units. C-L: see Literature 613S; also C-L: African and African American Studies 530S, Latin American Studies 613S, Arts of the Moving Image 644S
615S. The #Selfie. 3 units. C-L: see Literature 615S; also C-L: Arts of the Moving Image 615S, Visual and Media Studies 615S, Women's Studies 615S
664S. Leaders, Nations, and War. 3 units. C-L: see Political Science 664S

Jewish Studies

Courses in Jewish Studies (Jewishst)
541S. Jews and the End of Theory. 3 units. C-L: see Asian & Middle Eastern Studies 541S; also C-L: Literature 580S, International Comparative Studies 541S
550. Archaeology of Palestine in Hellenistic-Roman Times. 3 units. C-L: see Religion 550
601S. Introduction to Jewish Studies. An introduction to the topics and methods that are characteristic of Jewish studies as an academic and scholarly rubric in the contemporary university. The course engages both the history of Judaism as a religious culture and the history of Jewish Studies. Co-taught with faculty from UNC. Weekly meetings will alternate between Duke and UNC campuses. Instructor: Lieber. 3 units. C-L: Religion 613S, History 601S
607. Hebrew Prose Narrative. 3 units. C-L: see Religion 607
608. Classical Hebrew Poetry: An Introduction. 3 units. C-L: see Religion 608
609. Rabbinic Hebrew. 3 units. C-L: see Religion 609
610. Readings in Hebrew Biblical Commentaries. 3 units. C-L: see Religion 610
683. The Palestinian-Israeli Conflict in Literature and Film. 3 units. C-L: see Asian & Middle Eastern Studies 603

**Latino/a Studies in the Global South**

**Courses in Latino/a Studies in the Global South (LSGS)**


**Linguistics**

**Courses in Linguistics (LINGUIST)**

501. Cognitive and Neurolinguistics. The interrelationship between language and brain as described and analyzed in cognitive and neurolinguistics. Topics include localization theories, hemispheric dominance in language, language disorders, invasive and noninvasive scanning and imaging technologies (including ERP, EEG, fMRI, MEG), encoding and decoding of language at the phonological, morphological, syntactic, and semantic levels. Readings include scholarship from theoretical and cognitive linguistics, neurolinguistics, neurobiology, neuropsychiatry, and neuropsychology. Major research project required in form of research paper, laboratory or imagining experiment, or IRB document. Instructor: Andrews. 3 units. C-L: Russian 510, Neuroscience 501S

502S. Language, Brain, and Human Behavior. Explores the intersection of cognition and language by looking at a variety of theories of language, including: traditional models that vary according to how much the capacity for language is attributed to "the genes" or to "the environment" and newer models that question and redescribe traditional definitions of terms such as "nature," "nurture," genetic code," and "language." How traditional and new models of language interpret the capacity for language in its relationship to the neurosciences, the cognitive sciences, and the social sciences. Instructor: Tetel. 3 units. C-L: Psychology 670S

503S. Language Evolution and Acquisition. Both the phylogeny and ontogeny of language, i.e., both the wide and growing variety of scripts for the evolution of language in the human species and the various approaches to the emergence of language in the individual. The emergence of language in the individual and the particular language(s) the individual is exposed to, making linguistic relativity an important topic. Instructor: Tetel. 3 units. C-L: English 503S

506S. Semiotics and Linguistics (DS4). 3 units. C-L: see Russian 506S

510. Brain and Language (B, C). Focus on cognitive processes and brain mechanisms involved in language comprehension and production. Psycholinguistic models and how these models may be implemented in the brain. Instructor: Andrews. 3 units. C-L: Psychology 575, Neuroscience 510

512. Structure of French. 3 units. C-L: see French 512

512S. Topics in Spanish Linguistics. 3 units. C-L: see Spanish 512S

528S. Recent and Contemporary Philosophy. 3 units. C-L: see Philosophy 628S

560. History of the German Language. 3 units. C-L: see German 560; also C-L: Medieval and Renaissance Studies 607

561S. Second Language Acquisition and Applied Linguistics. 3 units. C-L: see German 561S

562S. Old Norse: Introduction to the Language of Viking Scandinavia. 3 units. C-L: see German 510S; also C-L: Medieval and Renaissance Studies 609S

564. Russian and Slavic Linguistics. 3 units. C-L: see Slavic and Eurasian Studies 564

590. Special Topics. Study of theoretical and applied linguistics. Contrast and comparison of both theoretical approaches and language groups is required. Topics to be announced. Instructor: Staff. 3 units.
590S. Special Topics in Linguistics. Same as Linguistics 590 except instruction is provided in a seminar format. Instructor: Staff. 3 units.

890. Special Topics in Linguistics. Advanced study of linguistic theory. Topics to be announced. Instructor: Staff. 3 units.

890S. Special Topics in Linguistics. Same as Linguistics 890 except instruction is provided in a seminar format. Instructor: Staff. 3 units.

Neuroscience Courses in Neurosci (NEUROSCI)
501S. Cognitive and Neurolinguistics. 3 units. C-L: see Linguistics 501; also C-L: Russian 510
502. Neural Signal Acquisition (GE, IM, EL). 3 units. C-L: see Biomedical Engineering 502
503. Computational Neuroengineering (GE, EL). 3 units. C-L: see Biomedical Engineering 503
504. Fundamentals of Electrical Stimulation of the Nervous System (GE, EL). 3 units. C-L: see Biomedical Engineering 504
507. Neuronal Control of Movement (GE, EL). 3 units. C-L: see Biomedical Engineering 517
510. Brain and Language (B, C). 3 units. C-L: see Linguistics 510; also C-L: Psychology 575
511L. Intermediate Bioelectricity (GE, EL). 4 units. C-L: see Biomedical Engineering 511L
515. Neural Prosthetic Systems (GE,EL,IM). 3 units. C-L: see Biomedical Engineering 515
517S. From Neurons to Development: The Role of Epigenetics in Plasticity. 3 units. C-L: see Biology 517S
533. Essentials of Pharmacology and Toxicology. 4 units. C-L: see Pharmacology and Cancer Biology 533
555S. Topics in Philosophy of Mind. 3 units. C-L: see Philosophy 555S
560. Molecular Basis of Membrane Transport (GE, EL, MC). 3 units. C-L: see Biomedical Engineering 560
584S. Hormones, Brain, and Cognition (B, C). 3 units. C-L: see Psychology 684S
590. Special Topics in Neuroscience. Topics vary by semester. Instructor: Staff. 3 units.
590S. Special Topics in Neuroscience. Topics vary by semester. Undergraduate as well as Graduate/ Professional students. Instructor: Staff. 3 units.
667S. Learning and Cognition in Humans, Animals, and Robots (B,C). 3 units. C-L: see Psychology 667S
672S. Cognitive Neuroscience of Memory (B,C). 3 units. C-L: see Psychology 672S
740L. Fundamentals of Bioelectric Engineering. 4 units. C-L: see Biomedical Engineering 740L
751. Neuroscience Bootcamp. Neuroscience Bootcamp is a two week immersive lecture, discussion and laboratory course for graduate students in the Neurobiology Graduate Program and the Cognitive Neuroscience Admitting Program, and graduate students in allied programs at the discretion of the instructors. The Duke Neuroscience Bootcamp is designed to (1) provide a common knowledge base of neuroscience fundamentals; (2) demystify the tools of the discipline - providing hands-on experience with techniques that are commonly used to explore cellular/molecular, circuits and cognitive neuroscience. Instructor: Platt, Mooney. 2 units. C-L: Neurobiology 751
755. Interdisciplinary Program in Cognitive Neuroscience (IPCN) Independent Research Rotation. Students will be involved in a research apprenticeship with a faculty member for hands-on experience with research efforts. Instructor: Staff. Variable credit.
780S. Foundations of Behavioral and Computational Neuroscience. 3 units. C-L: see Psychology 780S

Modeling Biological Systems Courses in Modeling Biological Systems (MBS)
573S. Modeling of Biological Systems. 3 units. C-L: see Mathematics 573S; also C-L: Computational Biology and Bioinformatics 573S
Theater Studies

Courses in Theater Studies (THEATRST)

520A. Theater in London: Text. A survey of drama from the Elizabethan period to the present based on performances offered by the Royal Shakespeare Company, Royal National Theatre, and other theaters in London and Stratford-Upon-Avon. Twenty plays will be seen and studied. Instructor consent required. Instructor: Staff. 3 units. C-L: English 583

530S. Translation Studies and Workshop. Through reading texts about translation and by doing an independent project translating part of a play, students develop skills in translation theory and practice, culminating in a public staged reading of their work. Each student chooses a different play, in source language of his/her own choice, and translates into English. Readings are seminal texts in translation studies covering topics such as globalization, adaptation, the translator's role, gender in translation, and postcolonialism to explore transmission of text/performance across cultures. Course is for graduate students and undergraduates. Enrollment limited. No previous translation experience required. Instructor: Conceison. 3 units. C-L: Romance Studies 520S, Asian & Middle Eastern Studies 502S

533S. Performance Studies. Introduction to theatrical transformations of traditional notions of drama into the broader category of performance, and to the performative field that seeks to understand them. Topics include the crossing of formal boundaries, the development of new technical possibilities, the role of uncertainty in the process of making a performance, and the purposes of performance, which range from the social to the spiritual and from the political to the personal. Theoretical readings and performances including works by Wagner, Artaud, Brecht, Benjamin, Chaplin, O’Neill, Stanislavski, Barthes, and Anderson. Instructor: Staff. 3 units. C-L: Literature 520S

535S. AfroFuturism. 3 units. C-L: see African and African American Studies 620S; also C-L: Dance 535S, Visual and Media Studies 524S

540A. Theater in London: Performance. Understanding the growth of a play from the script to final production, with focus on shows playing in London. Includes backstage theater tours, scene work, observations, audition workshops with theater practitioners, and supervised projects. Instructor consent required. Instructor: Staff. 3 units. C-L: English 584

590. Advanced Special Topics in Dramatic Literature (Lecture). Topics vary by semester. Consent of instructor required. Instructor: Staff. 3 units.

590S-1. Advanced Special Topics in Dramatic Literature (Seminar). Instructor: Clum or Foster. 3 units.

671S. Thinking Digital Cinema. 3 units. C-L: see Literature 614S; also C-L: Arts of the Moving Image 614S, Visual and Media Studies 614S

691. Independent Study. Individual directed study on advanced graduate level under supervision of a faculty member resulting in an academic or artistic product. Consent of instructor required. Instructor: Staff. 3 units.
Programs at Duke Kunshan University

Duke Kunshan University (DKU) is a partnership of Duke University and Wuhan University to create a world-class university offering a range of academic programs and conferences for students from China and throughout the world. DKU is located in Kunshan, Jiangsu province, China.

A state-of-the-art campus is under construction on a 200-acre site in the Kunshan Science and Technology Education Park. Located in close proximity to both Shanghai and Suzhou, and connected to both by high-speed rail, the city of Kunshan is a center for business and high-tech research and manufacturing, and has one of the fastest growing economies in China.

Duke Kunshan University will welcome its first graduate students in August 2014. Initial offerings include two graduate master's degree programs.

DKU Global Health
Research Professor Dear, Director of Graduate Studies, Master of Science Program;

A MS degree is available in this program.

The master of science in global health (MSc-GH) is administered by Duke Kunshan University (DKU), with support from the Duke Global Health Institute. A guiding principle of the degree program is the recognition that a multidisciplinary and multisectoral 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 thirty-eight-unit curriculum includes six core courses, five electives, a ten-week (minimum) field experience to apply learned research methods, and a research-based scholarly thesis. It is designed as a three-to-four-term program.

The six core courses are:
• Global Health 701K (Global Health Challenges)
• Global Health 702K (Global Health Research: Design and Practice)
• Global Health 705K (Global Health Research: Quantitative Methods I)
• Global Health 707K (Global Health Research: Quantitative Methods II)
• Global Health 740K (Ethics for Global Health Research)
• Global Health 750K (Health Systems in Developing Countries)

Students will select from a list of approved elective courses. Students are also required to complete a fieldwork experience of at least ten weeks, approved by the director of the MSc-GH program, and a research-based scholarly thesis.

Courses in Global Health (GLHLTH) at Duke Kunshan University

701K. 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. Taught at Duke Kunshan University. Instructor: Amaya-Burns. 3 units.

702K. Global Health Research: Design and Practice. Course provides a foundation in study design, research question development, field implementation, measurement, validity and reliability. Quantitative and qualitative research approaches are examined. Students build critical skills in reading, interpreting and synthesizing scientific literature. The selection of appropriate measurements and survey development is emphasized and issues in field implementation explored. Taught at Duke Kunshan University. Instructor: Abdullah. 3 units.

705K. Global Health Research: Quantitative Methods I. 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. Taught at Duke Kunshan University. Instructor: Dear. 4 units.

707K. Global Health Research: Quantitative Methods II. Modular course building on Quantitative Methods I. Required module provides common understanding of regression including linear, logistic, and general linear regression, use and interpretation of dichotomous and continuous variables, indicator terms, and interaction terms, and regression diagnostics. Required lab section. Taught at Duke Kunshan University. Instructor: TBD. 4 units.

740K. Ethics for Global Health Research. 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. Taught at Duke Kunshan University. Instructor: Amaya-Burns. 2 units.

750K. 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. Taught at Duke Kunshan University. Instructor: Tang. 3 units.

781K. 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. Course will be offered at Duke Kunshan University. Instructor: Dear. Variable credit.

790K. 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. Course will be offered at Duke Kunshan University. Instructor: Staff. 3 units.

791K. 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. Course will be offered at Duke Kunshan University. Instructor: Staff. 3 units.

DKU Medical Physics

Professor Yin, Director; Professor Huang, Site Director; Assistant Professor Bowsher, Director of Graduate Studies; Professors Das, Dewhirst, Dobbins, Frush, Howell, Huang, Izatt, Johnson, MacFall, Oldham, Provenzale, Samei, Smith, Allen Song, Spicer, Trahey, Vaidyanathan, Jackie Wu, Quwen Wu, Ying K. Wu, Yin, Zalutsky, Yoshizumi; Associate Professors Badea, Bida, Cai, Chang, Charles, Chen, Chin, Craciunescu, Driehuys, Kirkpatrick, Lo, Reiman, Segars, Tornai, Turkington, Wang, Wax, Yoo; Assistant Professors Adamson, Bowsher, Kapadia, Liu, Mazurowski, O’Daniel, Petry, Ren, Haijun Song, Truong; Accelerator Health Physicist Gunasingha.

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 an MS degree, and is organized into three academic tracks: diagnostic imaging physics, radiation oncology physics, and nuclear medicine 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 DKU and from sponsoring departments of the medical physics program at Duke University, which are radiology, radiation oncology, occupational and environmental safety (health physics), biomedical engineering, and physics. MS thesis projects may be performed with co-advisors from DKU and the medical physics program at Duke University. 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. The first semester of the second year is on the Duke University campus in Durham, North Carolina, where students attend classes and work on MS thesis research. The summer between first and second years may also be on the Durham campus, working on MS thesis research.
Courses Offered at DKU

500. Radiation Physics
505. Anatomy and Physiology for Medical Physicists
507. Radiation Biology
510. Radiation Protection
520. Radiation Therapy Physics
530A. Modern Medical Diagnostic Imaging Systems
541. Nuclear Medicine Physics
751. Seminars in Medical Physics
791. Independent Study in Medical Physics
744. PET and SPECT Image Reconstruction and Analysis

Courses Offered at Durham to DKU (and Duke) Students during First Semester of Second Year

722. Advanced Photon Beam Radiation Therapy
723. Advanced Brachtherapy/Special Topics and Procedures
731. Advanced Medical Imaging Physics
726. Practicum on Monte Carlo Methods in Medical Physics (*)
743. Basic Concepts of Internal Radiation Dosimetry (*)
728. Clinical Practicum and Shadowing (RT)
748. Clinical Practicum and Shadowing (NM)
792. Clinical Practicum and Shadowing (Diagnostic Imaging)

Course Offered during the Summer in Durham

729. Medical Physics Clinical Internship

(*) These two courses are offered only when there is sufficient student interest.

Courses in Medical Physics (MEDPHY)

500. 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 dosimetry. Consent of instructor required. Instructor: Gunasingha. 3 units.

505. 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., Pneumothrax in chest radiographs, microcalcifications in mammograms). Consent of instructor required. Instructor: Reiman. 3 units.

507. Radiation Biology. An introduction to radiation biology. This course will cover the biological effects of radiation, including mechanisms of DNA damage, and normal tissue injury. The principle context is with relevance to radiation therapy treatment. Instructor consent required. Instructor: Oldham, Dewhirst. 1 unit.

510. 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.

520. 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.

530A. 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.

541. 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.

722. 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: Medical Physics 520. Instructor: Das. 3 units.

723. Advanced Brachtherapy/Special Topics and Procedures. This course covers advanced LDR and HDR brachytherapy, and other selected special topics and procedures. Instructor consent required. Instructors: Yin, Craciunescu, Jackie Wu, Qiuwen Wu, Zh. Chang. 1 unit.

726. 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. Instructors: Gunasingha, H. Song, A. Kapadia. Variable credit.

728. 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: Wang, Craciunescu, Yoo, Zh. Chang, Ren, Steffey. 3 units.

729. 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.

731. 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: Medical Physics 530A. Consent of instructor required. Instructors: Dobbins, Badea, Bida, Liu. 3 units.

743. 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, and the MIRD methodology. Strategies to convert small animal radiopharmaceutical biodistribution data to humans will also be covered. Prerequisites: Medical Physics 500 and 505. Instructor: Reiman. 1 unit.

744. PET and SPECT Image Reconstruction and Analysis. This course will cover the basics of image reconstruction for tomographic imaging in nuclear medicine. Filtered backprojection and iterative methods will be explored, including methods for correcting physical effects such as attenuation and scatter. Basic concepts of image quality and quantitative use of PET and SPECT image will introduced. Prerequisite: Medical Physics 541. Instructor: Turkington. 1 unit.

748. Clinical Practicum and Shadowing (NM). The course gives hand on experience in clinical nuclear medicine. Students will work with gamma cameras, PET systems, surgical probes, dosemeters, 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: Turkington. 3 units.
751. **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: Kapadia, Oldham, Segars. 1 unit.

791. **Independent Study in Medical Physics.** An independent research project with faculty advisor. Consent of instructor required. Instructor: Staff. Variable credit.

792. **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: Biomedical Engineering 333/Medical Physics 530A or equivalent. Instructor: Samei. 3 units.
Bass Connections

Bass Connections is a new university-wide initiative launched by a $50 million gift from Anne and Robert Bass. The goal of Bass Connections is to create a distinctive new model for education, exploring societal and cultural challenges through collaborative, problem-centered learning. It engages faculty and students at all levels in teamwork, in integrating disciplinary approaches and professional practice, and in applying knowledge, research, and skills in problem solving. Launched in Fall 2013, Bass Connections provides opportunities for students to pursue problem-focused pathways through their Duke experience in five initial thematic areas:

- brain and society
- information, society, and culture
- global health
- energy
- education and human development
These pathways complement the study of a particular discipline, major, or profession, enabling students to focus on societal and cultural challenges, even while studying the liberal arts, learning a profession, or obtaining depth in a discipline.

Bass Connections also offers vertically integrated interdisciplinary project teams, connecting students and faculty throughout campus, along with visiting fellows from outside the university, to engage with issues of societal import.

All Bass Connections participants experience the complexity of global, societal problems in their real-world form, the value of integrating bodies of specialized knowledge, and the imperative of teamwork to begin finding solutions to the most pressing problems of the day.

For more information on Bass Connections and how to get involved, visit bassconnections.duke.edu.

University Institutes and Centers

Duke Global Health Institute

The Duke Global Health Institute (DGHI) is one of the leading academic centers for the study of global health. Recognizing that 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. It offers an innovative master of science in global health program, a graduate certificate in global health, and mentorship and support to Duke doctoral candidates pursuing global health research. Most programs require a field research experience in the United States or locations around the world. In addition to formal programs, DGHI engages students through seminars, conferences, and a journal club. For more information, visit the DGHI website 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, to advancing interdisciplinary research and education that transforms our understanding of brain function, and to providing innovative solutions for the challenges facing health and society. As one of Duke's Signature Institutes, 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 sciences, and engineering. DIBS administers the Cognitive Neuroscience Admitting Program, whose students later matriculate into the many PhD programs within the brain sciences. DIBS also partners with individual departments to support their PhD programs through student-focused events, sponsorship of collaborative research, and ongoing training programs.

For more information, visit the DIBS website at http://www.dibs.duke.edu/.

Center for Cognitive Neuroscience

The Center for Cognitive Neuroscience (CCN)—a unit of the Duke Institute for Brain Sciences—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 cognition, motor behavior, decision-making, and consciousness. Cognitive neuroscience is by its nature interdisciplinary. It addresses long-standing 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 the Trinity College of Arts & Sciences, the School of Medicine, the Pratt School of Engineering, and The Fuqua School of Business, 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 Cognitive Neuroscience Admitting Program (administered by DIBS) provides a point of entry for incoming PhD students, who complete coursework and laboratory rotations within the program before matching, during their second year, with 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
Institute for Genome Sciences & Policy

The Institute for Genome Sciences & Policy (IGSP) is a multi and interdisciplinary network of 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 faculty and students address far-reaching issues such as genomics and health, personalized medicine, genetic discrimination, the nature of humanity, comparative genome evolution, systems biology, intellectual property, the meaning of genome variation, large-scale data storage and analysis, and national health and science policy.

The IGSP is composed of faculty and students from across Duke University and is organized in a network of related programs that together form an integrated approach to advancing the Genome Revolution and addressing its implications for health and society.

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 Franklin Humanities Institute (FHI) is built on a collaborative model fitting Duke’s emphasis on facilitating interdisciplinarity. Through an array of innovative programs, we seek to encourage the conversations, partnerships, and collaborations that are continually stimulating creative and fresh research, writing, and teaching in the humanities at Duke. Since its inception, the FHI has been a key component in Duke’s overall strategic direction. The FHI played a key role in the 2000 strategic plan—Building on Excellence—and was designated as one of seven University Institutes in 2006.

The FHI is located in a 12,000 square-foot space in Smith Warehouse on Duke’s East Campus (Bays 4 and 5). Since 2010, the FHI has been home to the Humanities Labs, which contribute to Duke’s research and pedagogical missions by convening groups of faculty, graduate students, and undergraduates around discipline-crossing projects. The FHI’s Humanities Labs are a major part of a recent major grant from the A.W. Mellon Foundation to the university, entitled Humanities Writ Large.

The FHI is also home to the PhD Lab in Digital Knowledge, which began in Fall 2013. The lab provides an arena in which PhD students in humanities and interpretive social sciences can learn about new digital scholarship, engage with its challenges, and see its promise for their own research and professional lives within or outside the university. The PhD Lab is supported by the provost’s office, Trinity College of Arts & Sciences, and The Graduate School, along with the FHI.

FHI programs also include Faculty Book Manuscript Workshops and Interdisciplinary Working Groups. We host a wide range of public lectures, conferences, seminars/workshops, and other events throughout the academic year, notably our major Annual Distinguished Lecture and short-term scholars in residence.

In addition to its own programs, the FHI is home to the Duke Human Rights Center at the Franklin Humanities Institute (DHRC@FHI), the Center for Philosophy, Arts, and Literature (PAL), and the international organizations HASTAC (Humanities Arts Sciences Technology Advanced Collaboratory) and the Consortium of Humanities Centers and Institutes (CHCI).

For more information, please visit our website at http://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, nonprofits, and policymakers.

The institute promotes ethical reflection and engagement through its research, education, and practice in three core areas: moral education and decision-making, 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; www.dukeethics.org/.

Nicholas Institute for Environmental Policy Solutions

The Nicholas Institute for Environmental Policy Solutions improves environmental policymaking worldwide through objective, fact-based research to confront the climate crisis, clarify the economics of limiting carbon pollution, harness emerging environmental markets, put the value of nature’s benefits on the balance sheet, develop adaptive water management approaches, and identify other strategies to attain community resilience. The Nicholas Institute is led by a small team of economists, scientists, lawyers, and policy experts who draw on Duke University’s unparalleled resources at The Fuqua School of Business, the Trinity College of Arts & Sciences, the Sanford School of Public Policy, the Pratt School of Engineering, the Nicholas School of the Environment, and the Duke Law School to not only deliver timely, credible analyses to a wide variety of decision makers, but convene these decision makers to discuss and achieve common understandings regarding the century’s most pressing environmental problems.

Tim Profeta serves as director of the Nicholas Institute, which is composed of the following six programs: climate and energy, ocean and coastal policy, state policy, environmental economics, water policy and ecosystem services.

For more information about the Nicholas Institute for Environmental Policy Solutions and its opportunities for students, visit http://www.nicholasinstitute.duke.edu or e-mail nicholasinstitute@duke.edu.

Social Science Research Institute

The Social Science Research Institute (SSRI) strives to be a resource to all social and behavioral science scholars at Duke. SSRI offers training, tools, and facilities that bring scholars from across and beyond the social and behavioral science disciplines together to enhance their skills, thereby creating contacts and nurturing new collaborations. 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 hosting seminars that move society toward rational and informed discussions:

- BSPC: Behavioral Science and Policy Center
- CAH: Center for Advanced Hindsight
- CCFP: Center for Child and Family Policy
- CGGC: Center on Globalization, Governance & Competitiveness
- CRC: China Research Center
- D-CIDES: Duke Center for Interdisciplinary Decision Sciences
- DISM: Duke Initiative on Survey Methodology
- DNAC: Duke Network Analysis Center
- 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 website at http://www.ssri.duke.edu.

The Center for Child and Family Policy

The Center for Child and Family Policy brings scholars from many disciplines together with students, policymakers, and practitioners to address problems facing children in contemporary society. As 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. In addition, the center offers
graduate student fellowships which support the development of promising students who are interested in a career that blends basic social science with public policy.

The Center for Child and Family Policy is affiliated with Duke's Social Science Research Institute and is located in Rubenstein Hall, Duke Box 90545, Durham, NC 27708-0545; (919) 613-9303; [http://www.childandfamilypolicy.duke.edu/](http://www.childandfamilypolicy.duke.edu/).

The Duke Population Research Institute (DuPRI)

The Duke Population Research Institute, 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, codirector 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. M. Giovanna Merli, Duke University, Sanford School of Public Policy, Box 90097, Durham, NC 27708-0097.

School-based Interdisciplinary Centers

There are more than sixty 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 website at [http://interdisciplinary.duke.edu/](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 forty full-time faculty members at Duke and thirty 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. John Hope Franklin Center, 2204 Erwin Road, Box 90411, Duke University, Durham, NC 27708-0411. E-mail apsi@duke.edu or visit [http://www.duke.edu/APSI/](http://www.duke.edu/APSI/).

Center for Canadian Studies

Duke's strong tradition in Canadian studies dates back more than three decades. With first-rate faculty, excellent library resources, and strong administration support, the Duke Center for Canadian Studies has maintained its standing and produced scores of PhDs, many of whom are now teaching at colleges and universities in the United States and Canada.

The Center for Canadian Studies organizes interdisciplinary conferences, lectures, and film series. Additionally, the center offers undergraduate and graduate courses, which can be applied toward an undergraduate double major or minor, or a graduate certificate, on varying topics and themes, including Canadian history, literature, culture, security, energy, and United States-Canadian relations. The center also invites prominent Canadian scholars, distinguished guests, government officials, and business leaders to help promote the study and understanding of Canada. Furthermore, the center supports participation of Duke professors and graduate students in conducting research and language study in Canada, and at scholarly conferences in the United States and Canada.

For more information, please contact the Center for Canadian Studies program at the John Hope Franklin Center, 2204 Erwin Road, Box 90422, Durham, NC 27708; (919) 681-3262; [http://www.jhfc.duke.edu/canadianstudies/](http://www.jhfc.duke.edu/canadianstudies/).
Center for European Studies

The mission of the Duke Center for European Studies is to encourage interdisciplinary study, debate, and discussion of Europe, and to serve as a hub for regional and international programs promoting innovative European scholarship. The center cultivates all manner of intellectual life focused on Europe at Duke, and provides a unifying community for European scholars at Duke and neighboring institutions. The center has approximately 125-affiliated faculty and more than sixty graduate students across the humanities, social sciences, and several professional schools, and a larger network of scholars in institutions across the Triangle and North Carolina. We organize international conferences, sponsor regional seminar series, and invite European speakers. Additionally, the center offers a graduate certificate in European studies, and coordinates international exchange programs with European universities and research centers. Among the centers for European studies in the United States, we are distinguished by our historical vision of Europe, our focus on the European imperial legacy and on global connections, and our interest in cultural and religious issues, bridging the humanities and social sciences. For further information, please contact the Center for European Studies at the John Hope Franklin Center, 2204 Erwin Road, Box 90406, Durham, NC 27708; (919) 681-3262; 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 website 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 US 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 noncredit graduate seminars. For more information contact the Center for International Studies, 2204 Erwin Road, Box 90404, Durham, NC 27708-0404; http://ducis.jhfc.duke.edu/.

Center for Latin American and Caribbean Studies

The Duke Center for Latin American and Caribbean Studies (CLACS) coordinates graduate education in Latin American and Caribbean studies, and promotes research and dissemination of knowledge about the region. Its activities encompass the humanities, social sciences, natural sciences, and the professional schools.

CLACS, together with its consortium partner, the Institute for the Study of the Americas at UNC-Chapel Hill, has been awarded a Title VI grant from the Department of Education since 1991, making this one of the most successful National Resource Center Consortia in the nation.

In addition to funding from Title VI, CLACS has been awarded Andrew W. Mellon grants since 1990. These resources allow us to maintain a world-class faculty, fund graduate and faculty research in Latin America and the Caribbean, host visiting scholars and artists from the region, and promote outreach to local, state, and national educational, media, and business organizations.

Our Mission

• To create a supportive, intellectually stimulating, and interdisciplinary environment for students, faculty, and community members interested in the study of Latin America and the Caribbean.

• To bring together members of our local and worldwide community (K-16 schools, universities, scholars, artists, activists, civic organizations, etc.) in order to promote new ideas, research, and cultural awareness about Latin America and the Caribbean.
• To prepare better educated citizens and future leaders who may work in fields related to Latin America and the Caribbean in academics, business, arts, government, and many other careers.

We intend to fulfill this mission through:
• educational activities (guest speakers’ course development, visiting artists’ outreach to local schools, businesses and media; service-learning opportunities; certificate programs; etc.);
• research support (travel grants, conference awards, publications, conferences); and
• creating social networks and building community (collaborations with other universities, student organizations, and alumni; visiting professors; internships; social events).

CLACS is guided by a council of Latin Americanist faculty and staff members representing arts and sciences disciplines as well as professional schools. The center sponsors a speaker series, which provides a forum for presentations by visiting scholars, artists, and activists from throughout the United States and overseas, as well as Duke and UNC-Chapel Hill 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 and the UNC-Duke Consortium Conference. Opportunities for graduate students include FLAS funding for language training, conference and research grants, professional development through our conferences and consortia working groups, and a graduate certificate in Latin American and Caribbean studies.

For additional information about Latin American and Caribbean studies at Duke and courses with Latin American and Caribbean content offered by departments, see the chapter “Departments, Programs, and Course Offerings” on page 66. Graduate students interested in obtaining the certificate should contact the assistant director. For other inquiries, please contact the director or associate director, Center for Latin American and Caribbean Studies, Box 90254, Duke University, Durham, NC 27708-0254; (919) 681-3980; las@duke.edu; http://latinamerican.caribbean.duke.edu.

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, NC, 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, NC 27710. Or visit http://www.geri.duke.edu/ for more information.

Center for Documentary Studies

The Center for Documentary Studies (CDS), established in 1989, offers an interdisciplinary program in the documentary arts—photography, audio, film/video, narrative writing, and other means of creative expression—that
encourages active engagement in the world beyond the university campus. Much more than a traditional educational center, CDS encourages experiential learning in diverse environments outside the classroom, with an emphasis on the role of individual artists in contributing to society. In seminar-style courses, documentary studies students merge theory and practice in the making of original documentary work. In addition, CDS provides dark rooms, multimedia labs, screening rooms, and galleries for the creation and presentation of student work in conjunction with lectures and workshops involving prominent contemporary photographers, filmmakers, and other documentary artists.

At the graduate level, CDS offers courses and other opportunities as part of the master of fine arts in experimental and documentary arts program at Duke. Graduate students also may participate in a variety of documentary studies courses cross-listed with several Duke departments and programs, including art, art history and visual studies; public policy studies; arts of the moving image; history; English; sociology; and cultural anthropology. The CDS website lists documentary studies courses offered at the 700 level, which are open to graduate students for registration and credit. Center-sponsored projects offer a limited number of assistantships to graduate students in the arts and humanities.

CDS programs range widely to include undergraduate and graduate courses, continuing education classes, international awards, book publishing, radio programming, exhibitions, film production, and fieldwork projects in the United States and abroad.

For more information, check the CDS website at [http://documentarystudies.duke.edu](http://documentarystudies.duke.edu) or contact the director, Center for Documentary Studies, 1317 West Pettigrew Street, Durham, NC 27705; (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 more than one hundred doctoral-granting academic institutions and a contractor for the US 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; and
- 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; and
- 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 counselor: Keith Hurka-Owen, director, Office of Research Support, (919) 684-3030; or refer to ORAU’s website at [http://www.orau.org/](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](http://www.ors.duke.edu/grants-contracts-and-compliance).
• For nonmedical 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 use online resources, such as PIVOT and the Foundation Directory Online, which are available via the ORS website at https://ors.duke.edu/funding-search-tools. Once you are ready to begin writing a grant or fellowship application, you can access proposal writing guide resources at https://ors.duke.edu/orsmanual/proposal-preparation-and-writing. Before submitting a proposal, students will need to work with his/her home department and ORS for institutional review of his/her proposal, and also will need to begin the process of obtaining IRB approval for any human-subjects protocol that may be part of his/her 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, codirector, Center for Tropical Conservation, 3705-C Erwin Road, Simons Building, P.O. Box 90381, Durham, NC 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 graduate field courses in Costa Rica: Tropical Biology (twice per year—OTS-1 four weeks from late December to mid-January, and OTS-3 six weeks from June to July); and 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 February in Costa Rica); 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 and related fields are offered each year. Students can also apply for courses with the UK-based Tropical Biology Association (TBA) 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). Proposals are accepted twice each academic year. Information about OTS courses and fellowships is available from Duke’s OTS delegates: Kathleen Pryer in the Department of Biology, and Jennifer Swenson from the Division of Environmental Sciences and Policy in the Nicholas School of the Environment.

For more information contact OTS at 410 Swift Avenue, Durham, NC 27708; (919) 684-5774; ots@duke.edu; http://www.ots.duke.edu.
Resources for Study

The Libraries

The William R. Perkins Library, Bostock Library, and David M. Rubenstein Rare Book & Manuscript Library comprise Duke’s main library complex, which is joined on East Campus by the Lilly and Music Libraries, and by the Pearse Memorial Library at the Duke Marine Lab. Together with the separately administered libraries serving the schools of business, divinity, law, and medicine, they comprise one of the nation’s top ten private research library systems. 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 main library website at http://library.duke.edu is a gateway to the individual websites 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 have collaborated 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 authors elect to place in the open-access repository. This library-managed repository DukeSpace (http://dukespace.lib.duke.edu/dspace/) 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. Library users may search the holdings of all four member libraries through the Duke University Libraries website.

**Services Available to Graduate Students at Every Duke Library**

The descriptions below are intended only as a general overview. Contact a library 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. 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/course-support/course-reserves](http://library.duke.edu/course-support/course-reserves). These guidelines apply at Perkins Library, Lilly Library, and the Music 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.

**Document Delivery**

The document delivery and 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' website at [http://library.duke.edu/services/ask/](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 websites, and subject guides. Details are available at [http://library.duke.edu/services/instruction/](http://library.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 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 support for using the Sakai course management system, go to [http://cit.duke.edu/](http://cit.duke.edu/).

**Assistance With Copyright and Other Scholarly Communication Issues**

The university’s director of copyright and scholarly communication, 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 world religions. Areas of particular strength 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.
The selection of materials reflects the curricular offerings of Duke Divinity School and the Department of Religion at both the undergraduate and graduate levels, as well as the research programs of faculty in both divisions and doctoral candidates in the fields of religion and theology. Library users are welcome to submit purchase requests online.

Information about the Divinity School Library, including circulation policies and reference and instructional services, may be found on the library’s website at http://library.divinity.duke.edu/.

**The Ford Library at The Fuqua School of Business**

The Ford Library houses the principal business collections for the university, composed of thousands of 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 dozens of 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.

Additional information about the Ford Library may be obtained from library’s website at http://library.fuqua.duke.edu/.

**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 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 patrons with identifying the most relevant information resources, searching the literature, evaluating 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.

The MCLA website 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 website at 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 more than 625,000 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
Goodson Law Library website at http://www.law.duke.edu/lib/ can assist in all facets of legal research and library use. For contact information and initial research guidance visit the primary source and treatise material on both private and public international law topics. 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 website at http://www.law.duke.edu/lib/.

The Duke University Libraries System

The William R. Perkins Library, Bostock Library, and David M. Rubenstein Rare Book & Manuscript Library form the university’s main library complex.

PhD candidates who have passed their preliminary examinations may apply for a library carrel. Because of high demand, the library system maintains a carrel waiting list. Carrels are assigned on a first-requested, first-accommodated basis. For carrel use policies and reservation instructions, visit http://library.duke.edu/using/policies/carrels.

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 interdisciplinary and international focus. There are extensive collections from and about East and South Asia, Latin America, Africa, Europe, and the United States as well one of this country's largest collections of Canadiiana. 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 government documents.

Research 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 librarians, visit http://library.duke.edu/research/specialists.

The Libraries' Digital Collections Program builds distinctive digital collections that provide access to Duke's unique library and archival materials for teaching, learning, and research at Duke and worldwide. Particular digital collection strengths include advertising and consumer culture, documentary photography and film, Duke University and Durham history, African American history, women's history, transcultural experiences, and art, literature, and music. To browse the collections and related resources, visit http://library.duke.edu/digitalcollections/.

The holdings of the David M. Rubenstein Rare Book & Manuscript Library located adjacent to Perkins Library, range from ancient papyri to the records of twentieth-century advertising agencies. 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 US South, English and American literature, history of economic theory, history of medicine, African American history and culture, British and American Methodism, human rights and social justice, women's history and culture, and the history of modern advertising.

The Duke University Archives, part of the Rubenstein Library, is the official repository for records of the university, collecting, preserving, and administering materials that have continuing administrative or historical value. 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 30,000 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/reserves. Please allow three working days for the processing of your request.

The Music Library, also on East Campus, has a rapidly expanding collection of music scores, books, journals, and music-related media, encompassing more than 120,000 print items and 25,000 sound recordings in various
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.

The Library Service Center (LSC) is an off-site, high-density library repository designed to support the ever expanding growth of the libraries’ various collections. The center is located a short drive from the main campus off Highway 147 and Interstate 40. The LSC has a robust document delivery service available for all circulating material. Materials requested through the library catalog are retrieved and delivered within twenty-four hours Monday through Saturday morning.

One additional Duke library, the Pease 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;
- wired phone services (using Voice over IP);
- mobile computing applications;
- support for the use of multimedia in teaching, in cooperation with the Duke Center for Instructional Technology; and
- web design services.

You’ll find most everything you need to know about technology at Duke on the OIT website at http://www.oit.duke.edu, and on the special pages designed to support new members of the Duke community: http://www.oit.duke.edu/newtodu. To get help with information technology resources, contact the OIT Service Desk at http://www.oit.duke.edu/help or walk up to the Service Desk at The Link in the basement of Perkins Library. Service hours can be found on the OIT website at http://www.oit.duke.edu/help.

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

- Duke Office of Information Security: https://security.duke.edu/
- Duke Web Services: http://webservices.duke.edu/
- Information Technology Advisory Council: http://www.duke.edu/services/itac

Academic Technology Support

- Center for Instructional Technology (CIT): http://cit.duke.edu/

School-based IT Support

- Duke Divinity School: http://library.divinity.duke.edu/computing
- Duke University School of Law: law.duke.edu/actech/helpdesk/
- Duke University School of Nursing: https://nursing.duke.edu/current-students.tech-support
- The Fuqua School of Business: http://it.fuqua.duke.edu/
- 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 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 West Campus; the eleven-acre experimental plot and field laboratory; the Duke Forest, composed of 7,050 acres of woodland adjacent to West Campus; the field station for the study of ecology; and the Nicholas School of the Environment’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 coursework 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 instruction of students and in biological 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 composed of five separate facilities: the Phytotron, the Research Greenhouse, the Teaching Collection, the Field Station and the Botany plot. These facilities are dedicated to Duke University researchers and instructors.

The Phytotron

The Phytotron houses sixty-seven 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. Research space within the greenhouse is available for rent to Duke faculty and students; for more information, contact Michael Barnes at mb213@duke.edu.

Teaching Collection

The Teaching Collections greenhouses were constructed in 2009, directly adjacent to the Research Greenhouses, and are considered one of Duke’s hidden gems. This diverse reference display of plants is used for both research and
teaching. The collection features more than 1,800 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 collection 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. Tours are available by appointment only. Please contact in advance Jenny Gordon at jenny.gordon@duke.edu or Michael Barnes at mb213@duke.edu.

Field Station
The biological Field Station, located adjacent to the Duke Lemur Center, is the primary location for in-ground plant research trials. Open to all faculty and students, this protected two acres is used by plant geneticists and ecologists throughout the growing season, April to October. Field space is protected by an 8-foot-high fence to ensure the safety of the research from foraging deer.

Botany Plot
The Botany Plot on Cameron Boulevard is additional in-ground protected plant research space open to all labs for plant experiments.

Duke Forest
The Duke Forest is composed of more than 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 in 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 near the eastern edge of the piedmont plateau and supports a cross-section of the woodlands found in the upper coastal plain and the lower piedmont of the Southeast.

A variety of ecosystems, forest cover types, plant species, soils, topography, and past land-use conditions are represented within its boundaries. In terms of size, diversity, accessibility, and accumulated long-term data, the Duke Forest is a resource for studies related to forest ecosystems and the environment that is unmatched by any other university.

Academic use of the Duke Forest ranges from class instruction to long-term research projects, including studies on vegetation composition, landscape ecology, remote sensing, invertebrate zoology, atmospheric science, and global climate change. Background information available for teaching and research covers features such as soils, topography, forest cover, and management records; much of this data is electronically available in a geographic information system (GIS) format. A bibliography of past and current studies in the Duke Forest is also available.

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, or assistance in preparing fields by mowing, diskling, or planting. Staff can also assist in siting and mapping study areas using Global Positioning System (GPS) units and a GIS system.

All graduate students who wish to initiate research or lead class activities in the Duke Forest should contact Sara Childs, program director (Office of the Duke Forest, Duke University, North Building—Room 412; (919) 613-8013; sara.childs@duke.edu; www.dukeforest.duke.edu/) to discuss the project. Through a simple registration and approval process, students have the opportunity to use this invaluable resource to maximize their educational experience at Duke. Maps and gate keys ($10 deposit required) are available from the office.

Earth and Ocean Sciences Laboratories
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.
**Electron Microprobe Laboratory.** The electron microprobe lab, directed by Dr. Alan Boudreau, is used by the petrology and geochemistry groups at Duke and UNC-Chapel Hill. As such, it is an indispensable basic tool in mineral analyses. The machine consists of a Cameca CAMEBAX (French manufacture) electron microprobe with four wavelength-dispersive spectrometers, an energy dispersive spectrometer and digital electron microbeam imaging system. It is automated with control through PC operating system. The lab is part of a Duke-UNC shared laboratory facilities agreement.

**Geochemistry Laboratory.** Dr. Paul Baker's lab has all facilities necessary for major and minor wet chemical analysis. 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.

**Geochemistry Laboratories.** Instruments and laboratory facilities overseen by Dr. Emily Klein include the following instruments and laboratory equipment for sample preparation. (1) ARL-Fison Spectraspan seven direct current plasma (DCP) spectrometer, equipped with a twenty-four 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) for 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. 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 [http://www.thermo.com/com/cda/product/detail/1,1055,1,2080,00.html](http://www.thermo.com/com/cda/product/detail/1,1055,1,2080,00.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, South Carolina) for measuring low abundances of $^{224}\text{Ra}$ and $^{223}\text{Ra}$ activities (Moore and Arnold, 1996; Vinson et al., in press)
- Canberra high resolution Broad Energy germanium (BEGe) detector (BE5030) gamma spectrometry with 50 percent 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 $^{226}\text{Ra}$, $^{228}\text{Ra}$, $^{210}\text{Pb}$, and $^{137}\text{Cs}$ 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 $^{226}\text{Ra}$ in Mn-fibers after three-weeks incubation.

**Marine Biogeochemistry and Ecophysiology Laboratory.** The main objective of Dr. Nicolas Cassar's lab is to constrain the mechanisms governing carbon cycling, ocean fertility, the biological pump, ocean/atmosphere gas fluxes and carbon acquisition mechanisms in marine phytoplankton. The laboratory hosts several analyzers used in the lab and on ships: two quadrupole mass spectrometers, a cavity ring-down laser absorption spectrometer, optodes and a transmissometer. Several other peripherals include: high vacuum lines, pumps (peristaltic, gear and piston) and valve callos. Chemostats (or continuous-growth cultures) are also being built. See [http://www.nicholas.duke.edu/people/faculty/cassar/index.html](http://www.nicholas.duke.edu/people/faculty/cassar/index.html) for further details.

**Eco-hydrology and Bio-geomorphology Lab.** Dr. Marani’s laboratory will be equipped to address issues related to interacting geomorphological, hydrological, and biological processes, in tidal systems as well as in fluvial environments. The lab will include computing facilities to develop and run numerical models and to analyze remote sensing information. The lab will also include a water isotope analyzer, DGPS equipment and software, a VIS/NIR radiometer, an ADV system, a sonic anemometer, and sensors to characterize hydrologic states and fluxes (soil moisture probes as well as traditional rain gauges and weirs).

**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. Specialized research projects in forest economics, carbon cycling, and productivity are currently under way 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.

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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 thirty masters and thirty resident doctoral students. (For additional information concerning the PhD graduate programs refer to the chapter “Departments, Programs, and Course Offerings” on page 66 in this bulletin, and for the master of environmental management graduate program, refer to the bulletin of the Nicholas School of the Environment.) The Marine Laboratory accommodates nearly 3,700 visitors per year. The physical plant consists of twenty-three 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 fifty-seven-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, contact Auxiliaries Services, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516-9721; (252) 504-7652; 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 identify this interest to the director of graduate studies for the department to which they are applying. For information pertaining to the use of the Duke Lemur Center, graduate studies, or availability of research space, contact Dr. Erin Ehmke, erin.ehmke@duke.edu, Research Manager, Duke Lemur Center, 3705 Erwin Road, Durham, NC 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 the Bill and Melinda Gates Foundation. 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 Pratt 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 departments of physics and mathematics. Additional space is provided through the adjacent buildings such as Triangle Nuclear Building (TUNL), French Family Science Center (FFSC), and the Duke Free Electron Laser Laboratory (FEL). 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. Among the special equipment housed in the department are: 1 GeV linear accelerator; a high current electron storage ring driving an ultraviolet to soft X-ray Free Electron Laser (FEL) (this facility is used, among other things, to produce a high-intensity gamma-ray source known as the HIGS); 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. In addition the department houses a number of table top laboratories with state of the art equipment used in performing experiments in hard and soft condensed matter, biophysics, nonlinear and complex systems, and optics. Examples include ultrafast, high power, short wavelength, far-infrared and frequency-stabilized lasers, traps for ultra-cold atoms, high-speed oscilloscopes, classical and quantum optical telecommunication systems, entangled-photon sources, specially designed apparatus or soft matter experiments, conventional and ultra-high speed imaging equipment, cryostats, superconducting magnets, and associated equipment for research in condensed matter physics.

In addition a scanning electron microscope with electron beam lithographic capability and other materials processing equipment is housed in the Shared Materials Instrumentation Facility (SMIF). Located in the physics building is also an appropriately staffed instrument shop.

The department also contains several computers for data collection and processing in all of the research groups and a massively parallel computer system for use in particle, nuclear, and condensed matter theory research. Desktop computers are typically provided for all grad students. The computing infrastructure is maintained and supported by computing staff located in the physics building.

The physics building is located near the Bostock Library, which contains a large selection of books and scholarly periodicals.

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), 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. The Shared Materials Instrumentation Facility (SMIF) provides researchers with high quality and cost-effective access to advanced materials characterization and clean room fabrication capabilities. SMIF operates as a multidisciplinary shared use facility, and is available to Duke University researchers from the various schools and departments as well as to external users from other universities, government laboratories, and industry. SMIF is an official Duke University recharge center open to all trained students, staff, and faculty, and is used for both research and educational purposes. SMIF is housed in the Fitzpatrick Center for Interdisciplinary Engineering, Medicine and Applied Sciences (CIEMAS). The 11,000-square-foot facility consists of 4,000 square feet of class 100 and class 1000 clean room space, and more than 2,600 square feet of specialized laboratory space for characterization equipment. The remainder of the space is composed of facility support areas, staff offices, and a conference/classroom.

Facilities available for instruction and research are suggested by the following representative listing of equipment found in each department:

Biomedical Engineering. Biomechanics laboratories: 6 Terabyte RAID file server with LT03 nightly backup, mechanical testing systems, optical displacement measuring system, 64 bit, 4 node, 12 processor Beowulf Computer Cluster, Zonic modal analyzer, inverted microscopes and cell culture facilities. Biomedical materials and surface interactions laboratories: air- and water-cooled Argon lasers, air convection oven, capillary rheometer, gel permeation chromatograph, atomic force microscopes, ellipsometers, Real-Time PCR Detection Systems, liquid nitrogen cooled CCD camera, Nikon inverted microscope with phase contrast and epifluorescence, image analysis systems, vacuum oven, Zeiss axioplan microscope, cell culture facilities, electrophysiology and neurophysiology instrumentation. Ultrasound imaging and Biophotonics laboratories, surgical facility; CAD/CAM stations for circuit development,
diamond tip dicing saw, high-speed video system, image processing system, laminar flow hoods, multiple PCs and work stations, PC board maker, ultrasound mechanical scanner lasers, femtosecond pulsed light source, optical tables, basic electronic and optical instruments, such as oscilloscopes and optical power meters, and a full complement of opto-mechanical elements.

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 ten decades of sensitivity. Equipment is available for fabricating specimens and testing fiber-reinforced polymer composites. An environmental chamber tests in the temperature range of -100° to +350° 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, HPLCs, 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 PCs. 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 55 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; Matrix-assisted pulsed laser evaporation system; Ion Trapping Lab, equipped with a Ti:Sapphire laser, suite of diode lasers, vacuum chamber, Optoelectronics Testing Lab, equipped with 4K cryostat to test single photon detectors like visible
light photon counters (VLPCs) 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, biochemistry, 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, atomic force 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**

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 United States for the referral and treatment of serious diving accidents and air embolism cases and for patients with hypoxic and nonhealing 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 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 of the medical center campus 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, Joseph Levine Research Center, CIEMAS 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. A new 270,000 square foot Duke Cancer Institute opened in February 2012.

In the eastern section of the medical center campus are Pickens Rehabilitation Center, Civitan Mental Retardation and Child Development Center, and Trent Drive Hall. In the western section of the medical center campus are Surgical Oncology Research Building, Environmental Safety Building, Research Park Buildings I, II, III, and IV, the Vivarium, the Medical Science Research Buildings I and II, Genome Science Research Building, the Synderman Research Building, the Global Health Research Building, and the Cancer Center Isolation Facility.
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. Licenses to occupy space in these facilities are issued for the academic year. For more information, please contact housing, dining, and residence life 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://studentaffairs.duke.edu/hdrl. 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
Dining Services

Duke is home to one of the most innovative, dynamic, and cutting edge collegiate dining programs in the country. Our goal is to provide a delicious, nutritious, affordable community dining experience, no matter where you choose to eat on campus. Whatever your dietary needs or tastes, options abound.

Whether you have a hankering for a stacked deli sandwich, hand-cut steak or salad with locally grown greens, Duke Dining Services offers a variety of ways to tempt and please any palate. Our goal is providing a healthy and enjoyable experience, no matter where you dine on Duke’s campus.

From ethnic specialties and vegan entrees to low-fat desserts and down-home Southern cooking, there is a wide array of exciting and nutritious food options.

**Au Bon Pain** offers a variety of soups, salads, sandwiches, entrees, authentic artisan breads, and pastries. (Bryan Center)

**Bella Union** brews fresh coffee and offers fresh baked goods, frozen drinks, and novelty snack foods. (684-2326; McClendon Tower)

**Blue Express** offers a Mediterranean menu, including hot and cold sandwiches, hearty entrees, fresh salads, and desserts. (660-3971); Levine Science Research Center (LSRC)

**Divinity Cafe** offers organic and locally grown foods including vegetarian and vegan options. (668-3498; Duke Divinity School)

**Dolce Vita Cafe** is a full-service coffee bar serving mostly Organic Fair, Mighty Leaf Tea, sandwiches, salads, wraps, and pastries. (French Science)

**Duke Law Cafe**: Salads, sandwiches, and more. (613-8552; Duke Law School)

**Food Factory at Devil's Bistro**: For lunch, dinner, and late night we offer pizza, pasta, burgers, sandwiches, wraps, salads, grab and go, and dinner specials with beer and wine. Breakfast is also served Monday through Friday, and brunch is available on Saturday and Sunday. (660-3753; Central Campus)

**Freeman Center for Jewish Life**: This mecca of Duke’s Jewish life features Henry’s Place, a gourmet Kosher kitchen. Dinner is served Monday through Thursday, with special spreads for Friday Shabbat and Jewish holidays, including Passover. Vegetarians and those with dairy allergies are sure to find this location a treat. (684-0136; Faber Street)

**Grace’s Café** features authentic Asian cuisine as well as a selection of traditional American breakfast and lunch food. (660-3966; Trent Hall)

**Greek Devil**: Assorted Greek wraps and fresh roasted peanuts. (Bryan Center Plaza)

**Joe Van Gogh** offers freshly roasted coffee, with a menu of classic espresso drinks and high quality coffee from around the world as well as a selection of local pastries. (660-5078; Bryan Center)

**JB’s Gourmet Dogs & More** offers a variety of fresh, made-to-order hot dogs, including vegan and vegetarian options. (Penn Pavilion Plaza)

**Loco Pops on the Plaza**: Locally made handcrafted paletas/Mexican pops. (Bryan Center Plaza)

**Loop Pizza Grill** features pizzas, gourmet salads, fresh grilled fish, burgers, soups, desserts, and a “lite menu.” (Bryan Center)

**Marketplace** features an all-you-care-to-eat breakfast, dinner, and weekend brunch, a-la-carte weekday lunch, and late-night dining. Options include hot and cold breakfast items, made-to-order pasta, rotisserie meats, gourmet pizzas, ethnic cuisine, a full grill menu, and the salad bar. (660-3935; East Union)

**McDonald’s** is open twenty-four hours a day, seven days a week. (668-2404; Bryan Center)

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For more information, contact Duke Community Housing at (919) 684-4304 or e-mail housing@studentaffairs.duke.edu.
Nasher Museum Café: This sit-down restaurant serves a variety of locally grown and organic dishes, as well as upscale desserts and cappuccino-style beverages. (684-6032; Nasher Museum of Art)

Panda Express: Traditional Chinese favorites served fresh and quick (660-5080; Bryan Center)

Penn Pavilion: Multiple venues offering Southwestern, Italian, deli, bistro, comfort, sushi, Indian, salads, soups, and grab-n-go fare. Penn Pavilion is open for breakfast, lunch and dinner Monday through Friday and dinner on Sunday. It has an expanded plaza area for outdoor dining and wonderful views of the surrounding forest for inside dining (West Campus-Beside Bryan Center)

Pitchfork Provisions: This cafe, which is open twenty-four hours a day, offers a variety of fresh, eclectic fare. (684-3287; McClendon Tower)

Quenchers offers energizing smoothies, fresh-cut exotic fruit, energy bars, nutritional supplements, and trail mixes that compliment your healthy lifestyle. (660-3987; Wilson Center)

Red Mango: All-natural frozen yogurt, parfaits, smoothies, and coffee chillers (Coming Fall 2013 to the Bryan Center)

Saladelia @ The Perk: Where you can relax and enjoy fair trade, organic tea and locally roasted coffee with homemade desserts and pastries. Also serving healthy signature sandwiches, wraps, salads, and soups. (684-2049; Bostock Library)

Saladelia Cafe @ Sanford serves made-to-order sandwiches, fresh salads, gourmet soups, and specialty pastries. (613-7304; Sanford Institute of Public Policy)

Café at Smith Warehouse: Fresh deli sandwiches, salads, fruit and parfaits, ice cream treats, and hot and cold beverages. (423-6779; Smith Warehouse)

Terrace Café: Enjoy freshly made sandwiches and salads, ice cream bars, gourmet baked treats, and hot and cold beverages. (660-3957; Duke Gardens)

Trinity Café: This East Campus coffee bar serves gourmet coffees, smoothies, and fresh pastries. Light entrees, including salads, sandwiches, and sushi are also available. (660-3942; East Union)

Twinnie’s: This Irish pub offers hot out-of-the-oven breakfast pastries, made-to-order sandwiches, and fresh entrée salads in addition to its beer on tap and classic blends of coffee. (660-3944; CIEMAS)

Merchants-on-Points

Merchants-on-Points allow you to use your food points or your FLEX account to order from a variety of vendors, delivered right to campus from local off-campus restaurants. Merchants-on-Points delivers to Duke seven days a week, from as early as 10 a.m. to as “late” as 3 a.m.

Current Merchants-on-Points vendors include:
- The Pizzeria Cinelli’s (Italian)
- Chai’s Noodle Bar & Bistro (Asian)
- Dale’s Indian Cuisine (Indian)
- Domino’s (Pizza)
- Dragon Gate (Chinese)
- Enzo’s Pizza Co. (Italian)
- Food Factory at Devil’s Bistro (American)
- Grace’s Café (Chinese)
- Hungry Leaf (Salad)
- Jimmy John’s (Subs)
- Mediterra Grill (Mediterranean)
- Nosh (Eclectic)
- Palace International
- Papa John’s (Pizza)
• Pizza Mia Italian café
• Skewers (Kabobs & More)
• T.G.I.Friday’s (American)

Food Trucks
Food points can also be used for our food trucks. Food trucks are located throughout campus on select days to provide even more dining options. The calendar can be viewed at http://dining.duke.edu.
List subject to change. Visit the Duke Dining website for updated Merchants-on-Points and food truck vendors.

Special Diets
We want you to feel comfortable with your dining options and will help identify foods available on campus that fit into your diet.

Our registered dietician on staff, Toni Apadula, has specific training on all aspects of nutrition and is available to meet with you upon request. Should you have any questions or want some advice about nutrition, contact Toni at (919) 613-1218 or toni.apadula@duke.edu.

For more information on nutritional, dietary, and food allergen resources please visit the Duke Dining website at http://dining.duke.edu/nutrition-and-dietary-information.

More Information
Food purchases may be made in one of three ways: cash, a dining plan (food points), or a flexible spending account (FLEX). Information about DukeCard accounts is available from the DukeCard Office and online at http://dukecard.duke.edu.

Further information about campus dining locations and dining plan options is available from Duke Dining Services, (919) 660-3900. Stay up to date with the latest in dining news by visiting 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 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 activity. 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 health care 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) 681-9355, from 8:30 a.m. to 5 p.m. Monday, Tuesday, Thursday, and Friday, and from 9:30 a.m. to 5 p.m. Wednesday. Limited walk-in services are also available on a daily basis. An Acute Care Clinic is held on Saturdays during the fall and spring semesters from 9 a.m. to 12:45 p.m. Nurse advice is available at all hours when the SHC is closed by calling (919) 966-3820. See http://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.

Duke Student Wellness

Student Wellness staff are available to assist students in making informed decisions that promote their health. Topics include fitness assessment, alcohol and other drug usage, sexual activity and sexually transmitted diseases, stress management, and others. See http://www.studentaffairs.duke.edu/duwell for more information.

Student Health Physical Therapy

The Student Health Physical Therapy Consultation Service is coordinated through the Student Health Center, but is located on the first floor of the Duke Clinic Building, Clinic 1 E. A physical therapist is available weekdays when undergraduate classes are in session. Students are seen by appointment—call (919) 681-9255—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 fifty 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;
- physical exam;
- gynecological exam;
- laboratory services performed at Student Health: CBC, urinalysis, rapid tests for strep throat, mononucleosis, vaginitis, pregnancy;
- administration of allergy/immunotherapy shots;
- nutrition consultation;
- student health physical therapy; and
- health promotion services (DUWell).
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

- prescription drugs;
- laboratory services not listed above;
- x-rays and other radiology studies;
- vaccines;
- medical care provided in the Emergency Department, hospital, or other nonstudent 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; and
- 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 twenty-four hours per day during the twelve-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 directly from the insurance company. The charge (student only) for the SMIP will appear on the tuition bill and may be waived only by providing proof of adequate insurance coverage. Certain restrictions apply. See [http://studentaffairs.duke.edu/studenthealth](http://studentaffairs.duke.edu/studenthealth) for important enrollment and waiver information. 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 emotional, interpersonal, 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. Maintaining a highly competent, multiculturally diverse and multidisciplinary staff of mental health professionals committed to sustaining a healthy and inclusive learning community is central to CAPS’ vision. 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. In addition, CAPS offers a series of programs, support groups, and life-skills workshops. Recent offerings have focused on stress, anxiety, interpersonal relationships, meditation, yoga for mental health, eating and body image concerns, and grief support.

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 website at [http://www.studentaffairs.duke.edu/caps](http://www.studentaffairs.duke.edu/caps) or call (919) 660-1000.
The Career Center

All Career Center services are available to Duke students enrolled in The Graduate School and to alumni of its programs up to four years after graduation. Career Center staff support graduate students in the assessment of their career objectives and in the search for appropriate employment—whether in the academy, nonprofit, industrial, or government sectors. Services for graduate students include confidential one-on-one counseling, workshops for professional skill development such as interviewing and resume writing, and special events to connect them with campus resources, alumni career advisors, 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, and work with graduate students at all stages in their development. For information about our services, programs, and resources, see the graduate student section of the Career Center's website at http://www.studentaffairs.duke.edu/career/graduate-students.

Student Affairs

Cocurricular Activities

Graduate students at Duke University are welcome to use university recreational facilities such 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 filmmaking 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 Monday through Friday during the fall and spring and each Thursday during the first summer session.

The Center for Multicultural Affairs

The Center for Multicultural Affairs (CMA) supports the campus in addressing the academic and sociocultural needs of students of color (African, Asian, Latino, Native American, and multiracial/biracial) and conducts diversity education programs for the general student body. Additionally, the center offers the campus community a number of 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 http://www.studentaffairs.duke.edu/cma.
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, a listing of community-based federal work-study opportunities, and many other programs. In these ways, the CSC strives to raise awareness of contemporary social issues, support civic engagement, and strengthen partnerships between Duke University and Durham. Visit the CSC website at http://csc.civic.duke.edu/main/.

International House

International House’s mission is to provide services and advocacy to the international population at Duke as well as outreach to the Duke and Durham communities. The International House offers extensive cross-cultural programming and information to enhance the global mission of the university. I-House is part of the Division of Student Affairs.

International House staff conduct an intensive orientation at the beginning of each semester for incoming international graduate students. This year’s fall orientation will be held on August 12 and 13. The spring orientation will be held in early January 2015. Currently there are about 2,600 international students from more than one hundred countries enrolled at Duke.

Ongoing programs during the academic year include Friday morning Global Café and Thursday evening Extended Orientation Series, with a light supper provided. I-House also offers trips to Super Target, the Social Security Office, and the Department of Motor Vehicles. Programs for language and culture exchange include International Friends Program (matching internationals with local families); English Conversation Club, Spanish Conversation Hour, and Chinese Conversation Club (for casual conversation in a small group setting); and Duke Language Partners (pairing internationals with domestic students). International House also hosts extensive social and educational programs for spouses and partners throughout the year.

International House is open Monday through Friday from 8:30 a.m. to 5 p.m. throughout the year. Students may stop by during office hours with questions or concerns. The advisor on call will be available.

For more information about International House, visit http://www.studentaffairs.duke.edu/ihouse, e-mail ihouse@duke.edu, or call (919) 684-3585.

Jewish Life at Duke

Jewish Life at Duke is composed 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. Jewish Life at Duke offers all our programs to graduate students as well as undergraduate students. 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. Each Friday evening during the academic year, Jewish Life at Duke offers a variety of Shabbat opportunities around campus. Dining for Shabbat is provided through the generosity of the Benenson family. The Jewish Law Student Association, the Jewish Business Association and the Jewish Graduate and Professional Association also organize and coordinate special lectures, parties, and Shabbat opportunities for all Jewish graduate and professional students. The Triangle-wide Jewish Graduate Student & Young Professionals group plans social programming for Duke and surrounding schools throughout the year. Subscribe to our graduate and professional student e-mail listserv for up-to-date information about Jewish Life at Duke by e-mailing jewishlife@duke.edu and visit our website at 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://www.studentaffairs.duke.edu/lgbt.

The Mary Lou Williams Center for Black Culture

The Black graduate student presence at Duke University began in 1961 when the university desegregated the campus with the admission of three 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 and educator of students 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 in the Flowers Building, the Mary Lou Williams Center for Black Culture is a beautiful facility reflecting a vintage luxe aesthetic created by the hardwood floors, grand windows, custom carpets, an exquisite new digital grand piano, and an ever-expanding collection of photography and art 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://www.studentaffairs.duke.edu/mlw.

The Women's Center

The Women's Center facilitates discussions on feminism, gender equity, and social justice concerns; provides opportunities for civic engagement and activism, and provides advocacy, support, and referrals for women on campus. The center also serves as an advocate for individuals and groups experiencing gender-related concerns, such as sexual harassment, gender discrimination, or gender violence. Support is available anytime. 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 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 students for membership on university committees, oversees election of the graduate and professional Young Trustee, and coordinates social and community service events throughout the year. Representatives of each department and officers of the council are selected annually, but council meetings and most events are open to all graduate and professional students. GPSC also distributes GPSCNews, an electronic news digest, circulated weekly via e-mail. Please visit the GPSC website at http://gpsc.duke.edu/ to find out more about graduate and professional student organizations at Duke and for information on upcoming events. Please contact GPSC (gpsc@duke.edu) for additional details on how you can become involved.

Religious Life

Duke University Chapel, open from 8 a.m. to 10 p.m. during the academic year, provides a peaceful 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 a.m. each Sunday, a service of midweek prayer at noon on
Wednesdays in the Memorial Chapel, organ demonstrations at 12:30 p.m. on most weekdays, a service of prayer and communion on at 5:15 p.m. on Tuesdays, and a choral vespers service at 5:15 p.m. on Thursdays. Graduate students are invited to participate in a wide variety of religious life groups on campus. The one hundred-voice Chapel Choir is open by audition to all interested singers. For more information, visit chapel.duke.edu, or call (919) 681-9488.

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 7:45 a.m. Monday through Friday. Worship services are held 11:25 a.m. to 12:15 p.m. Tuesday, Wednesday, and Thursday of each week. For more information on services at Goodson Chapel, call (919) 660-3539.
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